

SELECTED



WATER

RESOURCES

ABSTRACTS



VOLUME 3, NUMBER 17
SEPTEMBER 1, 1970

Selected Water Resources Abstracts is published semimonthly for the Water Resources Scientific Information Center (WRSIC) by the Clearinghouse for Federal Scientific and Technical Information (CFSTI) of the Bureau of Standards, U. S. Department of Commerce. It is available to Federal agencies, contractors, or grantees in water resources upon request to: Manager, Water Resources Scientific Information Center, Office of Water Resources Research, U. S. Department of the Interior, Washington, D. C. 20240. Annual subscription is \$22.00 (domestic), \$27.50 (foreign), single copy price is \$3.00. Certain documents abstracted in this journal can be purchased from the Clearinghouse at the prices indicated in the entry. Prepayment is required.



U.S. Department of Commerce, Springfield, Va., 22151

SELECTED WATER RESOURCES ABSTRACTS

**'A Semimonthly Publication of the Water Resources Scientific Information Center,
Office of Water Resources Research, U.S. Department of the Interior**



**VOLUME 3, NUMBER 17
SEPTEMBER 1, 1970**

W70-06732 -- W70-07148

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifiers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.

- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin, jointly sponsored by the FWPCA, Soap and Detergent Association, and the Agricultural Research Service.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

In cooperation with the Federal Water Pollution Control Administration, the following "centers of competence" have been established:

- Thermal pollution at the Department of Sanitary and Water Resources Engineering of Vanderbilt University.
- Textile wastes pollution at the School of Textiles of North Carolina State University.
- Water quality requirements for freshwater and marine organisms at the College of Fisheries of the University of Washington.
- Wastewater treatment and management at the Center for Research in Water Resources of the University of Texas.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

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02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Non-Water Activities; Watershed Protection.

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08 ENGINEERING WORKS

Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

09 MANPOWER, GRANTS, AND FACILITIES

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10 SCIENTIFIC AND TECHNICAL INFORMATION

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ABSTRACT SOURCES

SELECTED WATER RESOURCES ABSTRACTS

01. NATURE OF WATER

1B. Aqueous Solutions and Suspensions

DIFFUSION COEFFICIENT OF SODIUM NITRATE IN AQUEOUS SOLUTION AT 25 DEG C AS A FUNCTION OF CONCENTRATION FROM 0.1 TO 1.0M,
Virginia Polytechnic Inst., Blacksburg. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 02K.
W70-06994

02. WATER CYCLE

2A. General

THE KINEMATIC CASCADE AS A HYDROLOGIC MODEL, Colorado State Univ., Fort Collins. Dept. of Civil Engineering.

David F. Kibler, and David A. Woolhiser.
Available from the Clearinghouse as PB-191 816, \$3.00 in paper copy, \$0.65 in microfiche. Colorado State University Hydrology No 39, March 1970. 27 p, 21 fig, 4 tab, 18 ref, 3 append. OWRR Project B-030-Colo (2).

Descriptors: *Overland flow, *Rainfall-runoff relationships, *Mathematical models, Model studies, Roughness (Hydraulic), Streamflow forecasting, Runoff forecasting, Open channel flow.
Identifiers: Kinematic wave theory, Kinematic cascade model, Watershed models.

A kinematic cascade is defined as a sequence of discrete overland flow planes or channel segments in which the kinematic wave equations are used to describe the unsteady flow. Each plane or channel is characterized by a length, width, and a roughness-slope factor. Outflow from the K-th plane, along with the parameters for planes k and k +1, establishes the upstream boundary condition for plane k +1. Nondimensional equations are presented for the K-th element in a kinematic cascade. Properties of the solutions for a kinematic cascade with pulsed lateral inputs are examined. Cascade solutions are compared with characteristic-analytic solutions and with experimental data for flow over a linearly converging section. (Knapp-USGS)
W70-06843

RUNOFF FROM WATERSHED MODELS,
State Univ. of New York, Syracuse. Coll. of Forestry.
Peter E. Black.
Water Resources Research, Vol 6, No 2, p 465-477, April 1970. 13 p, 8 fig, 1 tab, 35 ref.

Descriptors: *Rainfall-runoff relationships, *Hydraulic models, *Hydraulic similitude, *Simulated rainfall, Model studies, Simulation analysis, Soil water, Infiltration, Permeability, Base flow, Geomorphology, Rainfall intensity.
Identifiers: Watershed models.

Watershed models were used under a rainfall simulator to determine the nature of the hydrograph response to depth of surface storage medium, model slope, drainage pattern, and drainage density. Tests were made with carefully selected sponge material to represent soil under varying degrees of saturation. Geomorphic features have little or no effect on the hydrograph when there is surficial saturation, but under less than saturated conditions these watershed characteristics do materially affect hydrograph parameters. (Knapp-USGS)
W70-06993

NUMERICAL SOLUTION OF THE BOUSSINESQ EQUATION FOR AQUIFER-STREAM INTERACTION,
Stanford Univ., Calif.
George M. Hornberger, Janet Ebert, and Irwin Remson.
Water Resources Research, Vol 6, No 2, p 601-608, April 1970. 8 p, 9 fig, 23 ref. NSF Grant GK 4525.

Descriptors: *Surface-groundwater relationships, *Mathematical models, Groundwater movement, Base flow, Recession curves, Saturated flow, Unsaturated flow, Hydrographs, Hydrograph analysis.
Identifiers: Boussinesq equation.

An efficient numerical technique is used to obtain solutions of the Boussinesq equation for problems of groundwater recession and groundwater flow in response to changes in stream stage. The numerical results compare well with the analytical solution of Boussinesq. The solution of a problem involving changing boundary conditions on an aquifer because of a flood wave provides data relative to groundwater outflow. (Knapp-USGS)
W70-07004

EFFECTS OF FOREST COVER UPON HYDROLOGIC CHARACTERISTICS OF A SMALL WATERSHED IN THE LIMESTONE REGION OF EAST TENNESSEE, Tennessee Valley Authority, Knoxville.

Paul C. Sodemann, and Jones E. Tysinger.
French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 139-151, 1967. 7 fig, 3 tab, 9 ref.

Descriptors: *Rainfall-runoff relationships, *Watershed management, *Forest management, *Hydrologic budget, *Forest, Runoff, Limestones, Drainage, Drainage effects, Watersheds (Basins), Basins, Rainfall, Discharge (Water), Soil erosion, Gages, Gaging stations, Hydrography.
Identifiers: White Hollow Watershed (Tenn.).

The effect of forest cover on hydrologic characteristics was investigated by recording the precipitation, runoff, and sediment data of the White Hollow watershed in eastern Tennessee which is 2,68 square miles in area and underlain by Knox dolomite. The watershed was acquired by the Tennessee Valley Authority and placed under forest protection and management in 1934. The study, based on the data recorded during the 30-year period, shows the reduction of summer peak discharges and total sediment loads and a change in the time of distribution of surface runoff. No appreciable change has occurred in the water yield from the watershed and there has been no change in the volume of either surface runoff or groundwater runoff. (Gabriel-USGS)
W70-07081

2B. Precipitation

TIME DISTRIBUTION CHARACTERISTICS OF RAINFALL RATES, Illinois State Water Survey, Urbana.

F. A. Huff.
Water Resources Research, Vol 6, No 2, p 447-454, April 1970. 8 p, 6 fig, 2 tab, 6 ref.

Descriptors: *Rainfall disposition, *Time series analysis, *Rainfall intensity, Distribution patterns, Correlation analysis, Statistical methods, Time lag, Rainfall-runoff relationships, Urbanization, Cities.
Identifiers: Rainfall rates.

Data from a 50-storm sample on two dense networks in Illinois were used to investigate the time distribution of 1-minute rainfall rates in warm-season storms. Absolute and relative variability were analyzed for point and mean rates on areas from 25 to 100 square miles. Several variability

measures were employed including sequential variability that uses both the magnitude and the sequence of rates in characterizing the time distribution. Since the variability parameters were found to fit closely a log normal distribution, probability distributions were constructed to define interstorm variability relations. Both absolute and relative variability showed a wide range within and between storms, and between areas of different size. Little difference in variability properties was noted between rain and synoptic weather types associated most frequently with warm-season storms. No evidence of regular oscillations in the time distribution of rainfall rates in convective storms was shown by lag correlation analyses. (Knapp-USGS)
W70-06740

SCAVENGING STUDY OF SNOW AND ICE CRYSTALS,

Illinois Inst. of Tech., Chicago.

Sudesh K. Sood, and Meryl R. Jackson.

Report No IIIRI-C6105-10, Illinois Institute Technology Quarterly Progress Report, January 15, 1970. 25 p, 10 fig, 1 tab, 10 ref. USAEC Contract No AT (11-1)-578; IIIRI Proj. C6105.

Descriptors: *Fallout, *Precipitation (Atmospheric), *Aerosols, Laboratory tests, Snowfall, Chemical precipitation, Chemistry of precipitation, Crystallization, Flocculation, Dusts.
Identifiers: Aerosol scavenging.

Scavenging efficiency of naturally precipitating snow and ice crystals for 0.563 micrograms of latex singlets and doublets has been studied. The effect of crystal habit and size on scavenging efficiency has been determined using an electron microscope. Worldwide measurements on deposition of radioactive particles generated by nuclear explosions show that wet removal accounts for more than 80% of the total observed fallout. (Knapp-USGS)
W70-06744

SYNTHETIC RAINFALL DATA,

Nevada Univ., Reno. Desert Research Inst.

Charles K. Stidd.

Available from the Clearinghouse as PB-191 814, \$3.00 in paper copy, \$0.65 in microfiche. Nevada University Desert Research Institute Preprint No 66, April 1969. 11 p, 6 fig. OWRR Project No A-026-NEV (1).

Descriptors: *Precipitation (Atmospheric), *Statistical methods, *Synthetic hydrology, Statistical models, Weather forecasting, Data processing, Statistical models, Simulation analysis, Computer programs, Time series analysis, Frequency analysis, Forecasting.
Identifiers: Synthetic precipitation data.

A computer generated 'stationary time series' has been modified by processes analogous to those of natural precipitation-producing mechanisms. The resulting numbers have the distributional characteristics of precipitation data. By this means a quantitative explanation is obtained for the skewness in precipitation distributions and the cube-root-normal distribution is verified. (Knapp-USGS)
W70-06758

AIRBORNE TECHNIQUES IN CLIMATOLOGY: OASIS EFFECTS ABOVE PRAIRIE SURFACE FEATURES,

Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.

For primary bibliographic entry see Field 07B.
W70-06766

INCREASED PRECIPITATION FROM URBAN-INDUSTRIAL EFFECTS,

Illinois State Water Survey, Peoria.

For primary bibliographic entry see Field 04C.
W70-06918

Field 02—WATER CYCLE

Group 2B—Precipitation

IOWA PRECIPITATION,

Environmental Science Services Administration,
Des Moines, Iowa.

Paul J. Waite.

In: Water Resources of Iowa, Symposium Proceedings, Iowa Academy of Science at Univ of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, p 3-15, Jan 1970. 13 p, 12 fig, 13 ref.

Descriptors: *Precipitation (Atmospheric), *Iowa, *Distribution patterns, Synoptic analysis, Climatology, Data collections, Weather data, Rainfall disposition, Water sources, Weather patterns.

Precipitation data collected in Iowa from 1931-1960 are summarized, discussed, and shown graphically. Iowa's 225 precipitation sites are located about 15 miles apart. Control and inspection of sites and observers produces a reasonably good mesoscale precipitation climatology for Iowa. Generally, microscale precipitation climatology is lacking. The annual precipitation varies from near 25 inches in the northwest to 34 inches in the east-central and southeast counties. The crop season precipitation (April through September), totaling some two-thirds of the annual total, exhibits a less pronounced gradient of about 20 inches northwest to around 23 inches in most eastern and southern localities. The cyclic annual pattern of Iowa precipitation varies from little more than an inch in February to nearly 5 inches during June, a direct consequence of the availability of the moisture and the proximity of the eastward moving storms. On nearly half of all the days in the year a trace or more precipitation falls at all Iowa locations. This approximates about two-thirds of the cloudy (about 160 days) and the partly cloudy days (100 to 105 days). The preponderance of rainfall days are with small precipitation amounts. Snowfall, averaging little more than 30 inches per year has varied from a State average of 11.9 inches in 1965-66 to 59.0 inches in 1961-62. (See also W70-06981). (Knapp-USGS)
W70-06982

SYNTHESIS OF URBAN RAINFALL,

Auckland Univ. (New Zealand).

For primary bibliographic entry see Field 06A.
W70-06992

2C. Snow, Ice, and Frost

EVAPORATION OF WATER INTO A SUB-ZERO AIR STREAM,

Army Terrestrial Sciences Center, Hanover, N.H.
For primary bibliographic entry see Field 02D.
W70-06739

SOME CHEMICAL CHARACTERISTICS OF AEOLIAN DEPOSITS OF SNOW-SOIL ON PRAIRIE WETLANDS,

Fish and Wildlife Service, Jamestown, N. Dak.
For primary bibliographic entry see Field 02J.
W70-06801

GLACIERS OF THE CENTRAL CHILEAN ANDES AND THEIR IMPORTANCE TO THE WATER RESOURCES,

Geological Survey, Menlo Park, Calif.
Austin Post.
US Geological Survey Open-file report, 1970. 5 p, 1 tab.

Descriptors: *Glaciers, *Water sources, *Streamflow, *Runoff, *Water yield improvement, Melting, Regimen, Watershed management, Water supply, Water resources development, Droughts. Identifiers: Glacier melt modification, Central Andes, Chile.

Recent severe drought in central Chile requires maximum utilization of all water resources. Glaciers contain by far the largest volume of stored water in the area. Their maximum runoff occurs

during summer months and dry years when other sources of water are most depleted. By comparing the area of glaciers in river basins with basins in the North Cascades, Washington, where runoff data are available, it is estimated that a minimum of from 35 to 80 percent of the late summer runoff in five Chilean river basins is derived from glaciers. Glacier melt in central Chile for the past century has exceeded ice accumulation, so that streamflow records do not accurately reflect recent precipitation. Although glacier modification to increase runoff during drought is possible, artificial means of increased snow accumulation in glaciers may be required if this source of water is not to be lost. Scientific studies are essential to analyze and put to maximum use and eventually control this important water resource. (Post-USGS)
W70-06989

OBSERVATIONS ON THE GROWTH OF NEEDLE ICE,

Canterbury Univ., Christchurch (New Zealand).
Jane M. Soons, and David E. Greenland.
Water Resources Research, Vol 6, No 2, p 579-593, April 1970. 15 p, 6 fig, 5 plate, 3 tab, 12 ref.

Descriptors: *Frost, *Ice, *Freezing, Soil water, Soil water movement, Frost action, Heat balance, Humidity, Mass transfer, Thawing, Melting.
Identifiers: Needle ice (Frost).

Observations of needle ice were made in the field and in the laboratory. In both situations multtiered needles formed during a single freeze-thaw cycle. Four freeze-thaw cycles were induced in the laboratory. Ice needles grew during each cycle but became less abundant as the soil surface dried out. During the first cycle two-tiered needles grew; in later cycles a layer of frozen soil developed under a single layer of needles. Measurements of soil heat flow, changes of soil moisture, and loss of moisture by evaporation allowed calculations of the heat balance of the surface to be made. These measurements demonstrate the importance of heat released in the conversion of water into ice. Comparison of field and laboratory results shows a contrast in the mechanism of heat loss in the two situations (radiative as opposed to evaporative), but this contrast is unimportant in the formation of ice needles. Water availability appears to be a more important control of ice needle growth. Development of multtiered ice needles is not dependent on the number of freeze-thaw cycles but may result from a critical balance between the soil cooling rate, the amount of available moisture, and the release of heat by conversion of water into ice. (Knapp-USGS)
W70-07005

THE DISPOSITION OF SNOW CAUGHT BY CONIFER CROWNS,

Washington State Univ., Pullman; and Forest Service (USDA), Moscow, Idaho. Forestry Sciences Lab.

Donald R. Satterlund, and Harold F. Haupt.
Water Resources Research, Vol 6, No 2, p 649-652, April 1970. 4 p, 1 fig, 1 tab, 3 ref.

Descriptors: *Interception, *Snow, Snowfall, Snowmelt, Precipitation (Atmospheric), Water loss, Data collections.
Identifiers: Snow interception.

Snow interception studies during the warm winters of 1966-1967 and 1967-1968 in northern Idaho revealed that Douglas fir and western white pine saplings caught about one third of the snow that fell in 22 storms. More than 80% of the snow initially caught in the crowns ultimately reached the ground being washed off by subsequent rain, falling by direct mass release, or dripping as melting snow. Only a small portion was lost by evaporation. (Knapp-USGS)
W70-07008

2D. Evaporation and Transpiration

EVAPORATION OF WATER INTO A SUB-ZERO AIR STREAM,
Army Terrestrial Sciences Center, Hanover, N.H.
Yin-Chao Yen, and Gerald R. Landvatter.
Water Resources Research, Vol 6, No 2, p 430-439, April 1970. 10 p, 9 fig, 1 tab, 10 ref.

Descriptors: *Evaporation, *Laboratory tests, Mass transfer, Convection, Air temperature, Water temperature, Humidity, Air-water interfaces, Climatology, Energy budget, Cold regions.
Identifiers: Cold air.

Evaporation of water into sub-zero air stream to simulate water surface conditions during North American winters has been experimentally carried out in an air velocity range from 10 to 160 cm/sec and at air temperatures as low as 20 deg C below that of the water surface. The results can be well represented by an equation in which the Nusselt number for mass transfer is linearly related to the Reynolds number based on the length of the evaporating surface. This correlation gives a value about two and one-half times higher than the result calculated from the Bowen ratio. (Knapp-USGS)
W70-06739

EVAPORATION MEASUREMENTS BY AN EDDY CORRELATION METHOD,

Wisconsin Univ., Madison; and National Bureau of Standards, Washington, D.C. Inst. for Basic Standards.

S. M. Goltz, C. B. Tanner, G. W. Thurtell, and F. E. Jones.
Water Resources Research, Vol 6, No 2, p 440-446, April 1970. 7 p, 5 fig, 12 ref.

Descriptors: *Evaporation, *Humidity, *Eddies, *Data processing, *Meteorological data, Turbulence, Heat budget, Mass transfer, Instrumentation, Microenvironment, Weather data.
Identifiers: Eddy correlation.

Eddy correlation measurements of water vapor flux density were made by using a barium fluoride film humidity sensor and a three-dimensional anemometer. During morning and evening periods, good agreement was obtained between eddy correlation data and two other independent methods. Serious disagreement between measurements occurred only when the humidity sensor was operating within a poorly defined portion of the calibration curve that was not suited to on-line calculations. The humidity sensor could be modified to allow operation at all times within linear segments of the calibration curve, thereby permitting successful on-line computer calculations of eddy correlation vapor flux within one meter of the surface. (Knapp-USGS)
W70-06741

AIRBORNE TECHNIQUES IN CLIMATOLOGY: OASIS EFFECTS ABOVE PRAIRIE SURFACE FEATURES,

Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.
For primary bibliographic entry see Field 07B.
W70-06766

WATER REQUIREMENTS OF WATER-FOWL MARSHLANDS IN NORTHERN UTAH,
Utah Water Research Lab., Logan; and Utah State Univ., Logan. Cooperative Wildlife Research Unit.
For primary bibliographic entry see Field 06D.
W70-06995

Streamflow and Runoff—Group 2E

2E. Streamflow and Runoff

FLOODS IN THE UPPER DES MOINES RIVER BASIN, IOWA,
 Geological Survey, Iowa City, Iowa.
 Harlan H. Schwob.
 Geological Survey Open-file report, April 1970. 49 p., 1 fig, 15 plate, 3 tab, 7 ref, append.

Descriptors: *Floods, *Iowa, Surface waters, Streamflow, Stage-discharge relations, Profiles, Discharge (Water), Frequency analysis, Hydrologic data, Data collections, Stream gages, Gaging stations.
 Identifiers: Des Moines River basin (Iowa).

Data on flood stages, discharges, and frequency in the upper Des Moines basin, Iowa are provided in the form of flood-peak records, gaging-station records, frequency curves, and flood profiles. Information is provided for 253 miles of streams from near Boone on the main stem to the Iowa-Minnesota state line on the East and West Forks of the Des Moines River. Flood profiles on the main stem include those for the notable flood of 1954, the lesser flood of 1947, and the computed 25- and 50-year floods. Low-water profiles are shown for all reaches. Tabulations of flood stages and discharges at gaging stations contained in this report can be used for volumetric studies. They can also be used to study the time distribution of stage and discharge above a selected level. (Knapp-USGS)
 W70-06736

ERROR ANALYSIS OF STREAMFLOW DATA FOR AN ALLUVIAL STREAM,
 Geological Survey, Washington, D.C.
 For primary bibliographic entry see Field 07C.
 W70-06750

THE HYDRAULICS OF OVERLAND FLOW ON HILLSLOPES,
 Geological Survey, Washington, D.C.
 William W. Emmett.
 Report available for sale from Superintendent of Documents, U S Government Printing Office, Wash. D C 20402 - Price 75 cents. Geological Survey Professional Paper 662-A, pp A1-A68, 1970. 68 p., 41 fig, 6 tab, 42 ref.

Descriptors: *Overland flow, *Rainfall-runoff relationships, *Topography, Turbulent flow, Laminar flow, Slopes, Surface runoff, Sheet flow, Darcy-Weisbach equation, Discharge (Water), Model studies, Hydraulic models, Simulated rainfall, Erosion, Hydraulics, Chezy equation.
 Identifiers: Overland flow hydraulics.

Overland flow resulting from rainfall on natural hillslopes responds to the downslope increase in discharge by increasing its depth and velocity. Depth absorbs about two-thirds of the increase in discharge; velocity absorbs about one-third. For straight slope segments investigated in the field, resistance to flow remains nearly constant in the downslope direction. Values of resistance to flow expressed as Manning's n were as high as 1.0 and averaged about 0.5; this roughly corresponded to a Darcy-Weisbach friction factor of 100. Overland flow varies from laminar at the hilltop to fully turbulent at some distance down the slope. When no constraint is placed on slope, the slope for laminar flow increases downslope, the slope for turbulent flow decreases downslope, and a mixed or disturbed flow has an intermediate value or generally constant downslope gradient. This requires that a hillslope must have a convex upper segment, a straight middle segment, and a concave lower segment. This is the slope profile more often than not found in nature. Slope steepness and the length of each segment are controlled by the runoff rate and the initial gradient at the top of the slope. Thus the shape of each slope profile is related to its climatic and geologic environments. (Knapp-USGS)
 W70-06751

ANNUAL PEAK DISCHARGES FROM SMALL DRAINAGE AREAS IN MONTANA THROUGH SEPTEMBER 1969,
 Geological Survey, Helena, Mont.
 M. V. Johnson, and R. J. Omang.
 Geological Survey Open-file report, 1970. 139 p., 1 fig.

Descriptors: *Floods, *Small watersheds, *Montana, Stream gages, Peak discharge, Stage-discharge relations, Discharge measurement, Gaging stations, Data collections, Hydrologic data, Streamflow, Roads, Culverts, Hydraulic structures. Identifiers: Crest-gage stations.

A program to investigate the magnitude and frequency of floods from small drainage areas in Montana was begun July 1, 1955. About 200 stations were in operation from 1963 to 1967, and 185 were in operation in 1968 and 1969. This report is primarily a tabulation, by water year, of the annual peak stage and discharge at each crest-stage gaging station. Also, it summarizes the activities and progress made during the 1969 water year. The program objective is to obtain enough information on the magnitude and frequency of floods in various sizes and types of drainage basins to help design adequate highway drainage structures throughout the state. A method is given for determining the magnitude of floods with 10-yr and 25-yr recurrence intervals. (Knapp-USGS)
 W70-06752

MECHANICS OF OPEN-CHANNEL FLOW SYSTEMS,
 California Univ., Davis. Dept. of Water Science and Engineering.
 For primary bibliographic entry see Field 08B.
 W70-06760

QUANTITY AND QUALITY OF LOW FLOW IN THE HONDO CREEK BASIN, TEXAS, MARCH 27-28, 1968,
 Geological Survey, San Antonio, Tex.
 W. E. Reeves, and P. L. Rettman.
 Geological Survey Open-file report, November 1969. 9 p., 2 fig, 2 tab, 2 ref.

Descriptors: *Low flow, *Surface-groundwater relationships, *Recharge, *Water quality, *Texas, Limestones, Aquifers, Water loss, Infiltration, Data collections, Hydrologic data.
 Identifiers: Edwards limestone (Tex.).

A determination of the gains and losses in a 29.5-mile reach of Hondo Creek near Hondo, Texas, was made on March 27-28, 1968. A net loss of 106 cfs occurred in the reach that contributes recharge to the Edwards and associated limestones. The quality of water showed a general improvement downstream except for sites on and downstream from Verde Creek. (Knapp-USGS)
 W70-06774

HYDROLOGIC ENGINEERING TECHNIQUES FOR REGIONAL WATER RESOURCES PLANNING,
 Corps of Engineers, Davis, Calif. Hydrologic Engineering Center.
 For primary bibliographic entry see Field 07C.
 W70-06780

MAXIMUM UTILIZATION OF SCARCE DATA IN HYDROLOGIC DESIGN,
 Corps of Engineers, Sacramento, Calif. Hydrologic Engineering Center.
 For primary bibliographic entry see Field 07C.
 W70-06788

THE KINEMATIC CASCADE AS A HYDROLOGIC MODEL,
 Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
 For primary bibliographic entry see Field 02A.
 W70-06843

FLOOD COMPUTATIONS FOR SUBURBS,
 Pennsylvania State Univ., University Park. Dept. of Civil Engineering.
 For primary bibliographic entry see Field 07A.
 W70-06948

SURFACE WATER RESOURCES OF IOWA,
 Geological Survey, Iowa City, Iowa. Water Resources Div.
 Sulo W. Witala.

In: Water Resources of Iowa, Symposium Proceedings, Iowa Academy of Science at Univ of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, p 17-26, Jan 1970. 10 p., 3 fig, 1 tab, 3 ref.

Descriptors: *Water supply, *Runoff, *Distribution patterns, *Iowa, *Water resources, Water resources development, Streamflow, Mississippi River, Missouri River, Water yield, Surface waters. Identifiers: Surface water resources (Iowa).

The average annual runoff of Iowa ranges from about 2 to 8 inches. The State average is about 6 inches, an amount capable of supplying 5,820 gallons per day per capita. Because of the variability of flow, only a few percent of it is available on a firm basis. The 1960 withdrawal for public water supplies alone was equivalent to nearly 2 percent of the 5,820-gallon per capita supply. The Mississippi River at McGregor and the Missouri River at Sioux City each have an average annual runoff equivalent to about 23,000,000 acre feet. Together, these two stations have an annual flow more than 2 1/2 times the annual runoff from Iowa. No deficiencies in supply are expected for water users living within reach of these border streams. All but one of the four major reservoirs in the State are designed for essentially one purpose—flood control. As population and water use increase, consideration of storage to meet the needs for water supply, waste dilution, and other purposes will follow. (See also W70-06981). (Knapp-USGS)
 W70-06983

MAXIMUM FLOODS IN IOWA,
 Geological Survey, Iowa City, Iowa. Water Resources Div.
 Harlan H. Schwob.

In: Water Resources of Iowa, Symposium Proceedings, Iowa Academy of Science at Univ of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, p 79-86, Jan 1970. 8 p., 1 fig, 2 tab, 6 ref.

Descriptors: *Floods, *Iowa, Rainfall-runoff relationships, Snowmelt, Data collections, Discharge (Water), Stage-discharge relations, Stream gages. Identifiers: Flood frequency.

The history of floods in Iowa is briefly summarized. At present there are 116 complete-record gaging stations within the borders of the State. The drainage areas for these stations range from 1.33 to over 14,000 square miles. Additionally, as a cooperative project with the Iowa Highway Research Board, flood records are being collected at 134 crest-stage gages which have drainage areas ranging from 0.33 to 252 square miles. Data on maximum known floods for Iowa and for selected midwest states are shown in tables. Because of the relatively short record of streamflow in Iowa and adjacent states, it is not possible to compute the frequency of many extreme events. (See also W70-06981). (Knapp-USGS)
 W70-06986

RUNOFF FROM WATERSHED MODELS,
 State Univ. of New York, Syracuse. Coll. of Forestry.
 For primary bibliographic entry see Field 02A.
 W70-06993

AN EXPERIMENTAL INVESTIGATION OF RUNOFF PRODUCTION IN PERMEABLE SOILS,
 McGill Univ., Montreal (Quebec).
 For primary bibliographic entry see Field 02G.

Field 02—WATER CYCLE

Group 2E—Streamflow and Runoff

W70-06996

RECURRENCE INTERVALS BETWEEN EXCEEDANCES OF SELECTED RIVER LEVELS 3. ESTIMATION AND USE OF A PRIOR DISTRIBUTION,
New South Wales Univ., Kensington (Australia). Dept. of Statistics; and Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.
C. A. McGilchrist, T. G. Chapman, and K. D. Woodyer.
Water Resources Research, Vol 6, No 2, p 499-504, April 1970. 6 p, 2 fig 2 tab, 9 ref.

Descriptors: *Water levels, *Flood forecasting, *Frequency analysis, Statistical methods, Probability, Streamflow forecasting.
Identifiers: Flood frequencies, New South Wales (Australia).

The frequency of exceedance of identifiable levels in the banks of rivers has been shown to be approximately constant from site to site in New South Wales, Australia. The parameters of a model which describe this frequency at a site can therefore be regarded as a random selection from a prior distribution which describes the variations from site to site. By assuming an appropriate form for this prior distribution and estimating its parameters from data at a number of sites, the observed record at a particular site in the same region can be extended. (Knapp-USGS)

W70-06998

THE 3-PARAMETER LOGNORMAL DISTRIBUTION AND ITS APPLICATIONS IN HYDROLOGY,
Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.
B. P. Sangal, and Asit K. Biswas.
Water Resources Research, Vol 6, No 2, p 505-515, April 1970. 11 p, 3 fig, 4 tab, 11 ref.

Descriptors: *Statistical methods, *River forecasting, Frequency analysis, Streamflow forecasting, Flood forecasting, Probability.
Identifiers: Lognormal distribution.

The 3-parameter lognormal distribution is a general skew distribution in which the logarithm of any linear function of a given variable is normally distributed. The distribution is applied to the frequency analysis of floods, annual flows, and monthly flows, and a comparison with other commonly used methods suggests that it can be successfully used for this purpose. A procedure for its application has been suggested using only the median, the mean, and the standard deviation of the original data. The Gumbel distribution is a special case, and any straight line on the Gumbel probability paper can be transformed into a straight line on the log-normal probability paper by the 3-parameter log-normal distribution. The sample of 10 stations used in this study all exhibited negative skewness for the logarithms of the data and therefore the lognormal distribution that assumes this skewness equal to zero has generally given high estimates. (Knapp-USGS)

W70-06999

VARIATION OF THE LONGITUDINAL DISPERSION COEFFICIENT IN THE DELAWARE RIVER ESTUARY AS A FUNCTION OF FRESHWATER INFLOW,
Geological Survey, Philadelphia, Pa.
For primary bibliographic entry see Field 02L.
W70-07000

NUMERICAL SOLUTION OF THE BOUSSINESQ EQUATION FOR AQUIFER-STREAM INTERACTION,
Stanford Univ., Calif.
For primary bibliographic entry see Field 02A.
W70-07004

STATISTICAL ROUGHNESS PARAMETER AS INDICATOR OF CHANNEL FLOW RESISTANCE,

Pittsburgh Univ., Pa.
Chao-Lin Chiu, and G. Almanzar Rubio.
Water Resources Research, Vol 6, No 2, p 622-628, April 1970. 7 p, 5 fig, 1 tab, 5 ref. OWRR Project C-1146.

Descriptors: *Open channel flow, *Roughness (Hydraulic), *Alluvial channels, Froude number, Statistical methods, Stochastic processes, Channel morphology, Flow resistance.

Identifiers: Channel flow resistance.

In an analysis of field data of four natural rivers a statistical, large-scale roughness parameter has proved effective as an indicator of the channel resistance to the flow when the Froude number based on the mean annual flow is larger than about 0.2. The parameter is derived from the concept that the irregular shape and slope of an irregular alluvial channel may be considered as a result of the random walk of 'imaginary particles' along the channel bed. It is the so-called diffusion coefficient which, according to the stochastic theory of the diffusion process, is normally defined in a diffusion equation as the mean square or the variance of the displacement of the particles during a step of random walk over a constant time interval of length delta t divided by 2 delta t. In the present study, however, delta t represents a constant distance interval instead. The parameter proved to have characteristics similar to those of another large-scale roughness parameter that is derived by other investigators from concepts other than the statistical. This roughness parameter provides a new statistical geometric measure of the irregularities along the entire channel bed and sides that is related to the probability of channel geometry through the diffusion equation, which provides the conceptual basis for its use as a roughness parameter. (Knapp-USGS)

W70-07013

VELOCITY MEASUREMENT WITH RADIOACTIVE SPHERES,

Illinois Univ., Urbana.
For primary bibliographic entry see Field 07B.
W70-07015

FLOODS IN SYMERTON QUADRANGLE, NORTHEASTERN ILLINOIS,

Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 07C.
W70-07017

STATISTICAL MODEL OF TURBULENCE IN SEDIMENT-LADEN STREAMS,

Kansas State Univ., Manhattan; and Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 02J.
W70-07022

WATER RESOURCES OF THE PINE RIVER BASIN, SOUTHEASTERN MICHIGAN,

Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 07C.
W70-07028

A PILOT STUDY OF STORAGE REQUIREMENTS FOR LOW FLOW AUGMENTATION,

Corps of Engineers, Sacramento, Calif. Hydrologic Engineering Center.
For primary bibliographic entry see Field 05G.
W70-07029

THE BASIC HYDROLOGIC CHARACTERISTICS OF THE KARST RIVER LJUBLJANICA,

Hydrometeorological Inst., Ljubljana (Yugoslavia).
Friderik, Lewicki.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 255-262, 1967. 1 fig, 2 tab.

Descriptors: *River flow, *Karst, *Surface-ground-water relationships, *Hydrogeology, River basins, Flow characteristics, Floodwater, Groundwater basins, Runoff, Precipitation (Atmospheric), Infiltration, Water storage, Water supply, Water level fluctuations, Springs, Gaging stations, Discharge measurements.
Identifiers: Ljubljanica river, Yugoslavia.

The hydrologic characteristics of the Ljubljanica river flowing over the surface of a karstic area were investigated by analysis of water-discharges and other pertinent data. The analyzed data for the river then were compared with the similar hydrologic data characterizing the neighboring Sava and Soco rivers. During periods of heavy precipitation in flat areas, where water flows above ground levels, floods occur owing to the small infiltration capacity of the surface layer. Since the water is both retained on the surface of karstic areas and accumulated underground, the springs in the Ljubljanica river area are fairly constant. The special hydrologic characteristics of Ljubljanica, caused by the karstic features of the drainage basin, have a considerable effect on the downstream hydrologic conditions, especially those of the Sava river. (Gabriel-USGS)
W70-07091

VARIATION OF ALPHA AND BETA VALUES IN A LINED OPEN CHANNEL,

Colorado State Univ., Fort Collins. Coll. of Engineering, and Geological Survey, Fort Collins.
Frederick J. Watts, Daryl B. Simons, and Everett V. Richardson.

Journal of the Hydraulics Division, ASCE Proceedings, Vol 93, No HY6, p 217-234, November 1967. 9 fig, 2 tab, 5 ref, append. Paper 5593.

Descriptors: *Open channel flow, *Mathematical studies, *Mannings equation, *Discharge coefficients, Reynolds number, Roughness (Hydraulic), Uniform flow, Energy, Hydraulics.
Identifiers: Open channel hydraulics.

A study of the variation in magnitude of the energy coefficient, alpha, and the momentum coefficient, beta, was conducted for subcritical open-channel flow in concrete-lined trapezoidal canals containing horizontal curves. The Manning's n was 0.013 for reaches without bends; values of alpha and beta were found to be smaller than values proposed in current literature, and there was only small variation of alpha and beta values with stage, channel geometry, position, and radius of curvature. For all cross sections analyzed, the energy and momentum coefficients may be considered constant with values of 1.04 and 1.02, respectively. (Knapp-USGS)
W70-07092

2F. Groundwater

RECORDS OF OBSERVATION WELLS AND WATER-LEVEL FLUCTUATIONS IN THE ABERDEEN-SPRINGFIELD AREA, BINGHAM AND POWER COUNTIES, IDAHO, IN 1968

Geological Survey, Boise, Idaho.
For primary bibliographic entry see Field 04B.
W70-06732

GROUND-WATER CONDITIONS IN ANGELINA AND NACOGDOCHES COUNTIES, TEXAS.

Guyton (Willian F.) and Associates, Austin, Tex.

Report published and distributed by the Texas Water Development Bd, P O Box 12386, Austin, Texas.

Tex. 78711. Texas Water Development Board Report 110, March 1970. 125 p, 47 fig, 12 tab, 54 ref.

Descriptors: *Water resources, *Groundwater, *Aquifers, *Texas, Water wells, Water yield, Water quality, Transmissivity, Water supply, Sands, Sandstones, Water levels, Withdrawal, Water resources development, Recharge, Discharge (Water), Water utilization.

Identifiers: Angelina County (Tex), Nacogdoches County (Tex).

Groundwater conditions were surveyed in Angelina and Nacogdoches Counties, in the rolling hills, piney woods portion of east Texas. The geologic formations which constitute the principal aquifers are the Carrizo Sand, Wilcox Group, Yegua Formation, and Sparta Sand. Of these the Carrizo is by far the most productive. Each of the formations crops out in the area and dips to the south. Because the aquifers are full to overflowing, most of the recharge is rejected in the outcrops as evapotranspiration and seepage in the stream valleys. Total pumpage from Carrizo wells in 1968 is estimated at 26.7 million gpd. Yields of individual wells range from a few gallons per minute to nearly 1,500 gpd. The estimated total supply available from Carrizo wells under practical conditions, without causing the failure of some of the present well fields and drying up portions of the aquifer, is 32 million gpd. Pumpage from the Wilcox Group was only 0.5 million gpd in 1968. The estimated potential yield of the Wilcox sands to wells is 8 million gpd. Estimated pumpage from the Yegua Formation in 1968 was 2.8 million gpd. The estimated potential yield from wells in the Yegua Formation is 7 million gpd. Estimated pumpage in 1968 from the Sparta Sand was only 0.1 million gpd. The estimated potential yield of this sand to wells is 7 million gpd. No evidence has been found of any serious contamination of groundwater from oil-field brines. There is some possibility of future encroachment of brackish water in the Carrizo and Yegua Formations. (Knapp-USGS)

W70-06737

GROUNDWATER DATA FOR ORANGE COUNTY AND VICINITY, TEXAS AND LOUISIANA, 1969,

Geological Survey, Austin, Tex.

Gene D. McAdoo.

Geological Survey Open-file report, 1970. 22 p, 4 fig, 5 tab, 2 ref.

Descriptors: *Hydrologic data, *Water levels, *Water quality, *Aquifers, Texas, Groundwater, Water level fluctuations, Louisiana, Water utilization, Water yield, Withdrawal, Water wells, Monitoring, Data collections.

Identifiers: Orange County (Tex).

A network of 94 observation wells was maintained for water-level measurements during 1969 in Orange County, the southern parts of Jasper and Newton Counties, the eastern part of Jefferson County, the southeastern part of Hardin County, all in Texas; and the western parts of Cameron and Calcasieu Parishes, Louisiana. The heaviest concentration of observation wells is within the industrial area in the southern part of Orange County. The locations of water-level observation wells are shown on a map. Static water-level measurements were made generally in the early part of the year at the time of least interference from pumping and maximum recovery from the previous heavy seasonal pumping. Pumping water-level measurements were made during the latter part of the year at the time of maximum drawdown of water levels. A network of 58 wells to observe changes in chemical quality of the groundwater was maintained during 1969 in Orange County. Data on groundwater pumpage for all major uses during the period 1963-68 are given. (Knapp-USGS)

W70-06746

HYDROGEOLOGICAL RECONNAISSANCE OF THE NORTH NASHWAAKSIS BASIN, NEW BRUNSWICK,

Department of Energy, Mines and Resources, Ontario (Ontario). Inland Waters Branch.

J. E. Charron.

Inland Waters Branch Technical Bulletin No 20, Department of Energy, Mines and Resources, 1969. 48 p, 36 fig, 7 tab, 7 ref.

Descriptors: *Hydrogeology, *Groundwater basins, Aquifers, Water wells, Water quality, Geohydrologic units, Surveys, Investigations, Water sources, Water levels, Water yield.

Identifiers: *Nashwaaksis basin (New Brunswick), Canada.

The North Nashwaaksis basin (New Brunswick, Canada) is one of three small perched basins, situated on a plateau between the larger Keswick and Nashwaak River basins. Surficial deposits consist of impermeable glacial-deposited till (ground moraine) and some bouldery outwash along the bed of the North Nashwaaksis Stream near the southern end of the basin. Bedrock is for the most part relatively uniform, almost horizontal, permeable sandstone with some conglomerate rocks outcropping. Reconnaissance of the area consisted of traversing the basin throughout its entire length to locate springs and future drill sites, gather water samples, map rock outcrops and find areas of recharge. The data collected provided a basis for the study of three specific aspects of the hydrogeology of the basin: (1) a temperature study of surface and subsurface water; (2) a partial quantitative study of the sandstone aquifer that underlies the basin; (3) a very good hydrochemical interpretation of groundwater movement as shown by the analyses of 37 surface and subsurface water samples. In addition, some of the data collected can be used in a low flow study of the basin. (Knapp-USGS)

W70-06765

HYDROGEOLOGY OF THE BEREAL AND CUSSEWO SANDSTONES IN NORTHEASTERN OHIO,

Geological Survey, Washington, D.C.

For primary bibliographic entry see Field 07C.

W70-06784

GROUNDWATER FAVORABILITY AREAS AND SURFICIAL GEOLOGY OF THE LOWER KENNEBEC RIVER BASIN, MAINE,

Geological Survey, Washington, D.C.

For primary bibliographic entry see Field 07C.

W70-06790

GROUNDWATER RESOURCES OF CRAVEN COUNTY, NORTH CAROLINA,

Geological Survey, Washington, D.C.

For primary bibliographic entry see Field 07C.

W70-06791

COARSE MEDIA FILTRATION FOR ARTIFICIAL RECHARGE,

Illinois State Water Survey, Urbana; and Tennessee Valley Authority, Chattanooga.

For primary bibliographic entry see Field 04B.

W70-06793

GENESIS OF SOME GROUNDWATERS FROM IGNEOUS ROCKS,

Northwestern Univ., Evanston, Ill. Dept. of Geological Sciences.

For primary bibliographic entry see Field 02K.

W70-06799

THE EQUATION OF GROUNDWATER FLOW IN FIXED AND DEFORMING COORDINATES,

Geological Survey, Washington, D. C. Water Resources Div.

Hilton H. Cooper, Jr.

Journal of Geophysical Research, Vol 71, No 20, p 4785-4790, October 15, 1966. 6 p, 7 ref.

Descriptors: *Groundwater movement, *Mathematical studies, Flow, Porous media, Darcy's law, Permeability, Non-uniform flow, Unsteady flow, Drawdown, Transmissivity, Porosity, Storage coefficient.

Identifiers: Jacob's equation.

Two forms of the equation of flow of a compressible liquid in an elastic porous medium are derived by considering mass conservation in (1) a control volume whose boundaries are fixed in space and (2) a control volume that deforms and moves through space when the material deforms. The first method yields a form of the equation that necessarily involves the velocity of the grains of the medium. The second yields a form that does not involve the grain velocity. Jacob's equation is found to be correct when negligible terms are omitted. (Knapp-USGS)

W70-06802

ON THE STORAGE COEFFICIENT AND THE EQUATIONS OF GROUNDWATER FLOW,

Princeton Univ., N. J. School of Engineering and Applied Science.

Roger J. M. De Wiest.

Journal of Geophysical Research, Vol 71, No 4, p 1117-1122, February 15, 1966. 6 p, 2 fig, 10 ref.

NSF Grant GE-7269.

Descriptors: *Storage coefficient, *Aquifers, Mathematical studies, Groundwater, Groundwater movement, Darcy's law.

Identifiers: Specific storage.

Specific storage of an elastic aquifer is redefined, and the storage coefficient which was first computed by C. E. Jacob is derived in the transition from three-dimensional flow to two-dimensional flow. The equation for groundwater flow in a homogeneous, isotropic medium is derived from the exact expression of Darcy's law for compressible fluid flow. (Knapp-USGS)

W70-06803

AN APPROACH TO MANAGEMENT AND OPTIMAL UTILIZATION OF AQUIFERS,

Technion - Israel Inst. of Tech., Haifa.

Jacob Bear, and O. Levin.

In: Proceedings of the Second Annual American Water Resources Conference, American Water Resources Assn., Urbana, Ill., 1966. p 200-212, 4 fig, 2 ref.

Descriptors: *Aquifers, *Artificial recharge, *Aquifer characteristics, *Hydrology, *Groundwater, *Groundwater recharge, *Leakage, *Management, *Mathematical models, *Planning, *Optimization, *Natural recharge, *Recharge, *Safe yield, Water resources, Water supply, Storage, Reservoir storage, Spring waters, Import, Export, Seasonal, Conduits, Flow, Filters, Mixing, Constraints, Benefits, Distribution systems, Quality control, Legal aspects, Technology, Boundary processes, Decision making.

Identifiers: *Excitation-response relationships, *Aquifer geology, *Groundwater utilization, *Marginal analysis, Import-export relationships, Stochastic input, Single cell aquifers, Mixers, Controlled pumpage, Technological aspects, Objective functions.

The role of groundwater aquifers in developed water resource systems as renewable sources of water, as large storage reservoirs, conduits and distributional systems, controls for spring and river flow and as filters or mixers of injected water in quality control operations, is described and analyzed. Groundwater hydrology describes the excitation-response relationships in an aquifer. The conventional approach where decisions by hydrologists and planners on groundwater utilization are based solely on physical relationships, and on the knowledge of aquifer geology, is described.

Field 02—WATER CYCLE

Group 2F—Groundwater

The drawback of defining safe yield according to this physical approach and the need for other criteria are discussed. The problem of groundwater utilization is formed as a management problem where the aquifer is to be operated in an optimal manner. The mathematical model on which this approach is based is described. They hydrological excitation response relationships serve as constraints for the operation of the system. Sometimes technological, legal or other restrictions are also involved. The dynamic nature of the problem and the special features of the aquifer: stochastic input in the form of natural replenishment and the leakage through boundaries, depending on water table elevations, is discussed. The solution of the aquifer management problem is based on known optimization techniques in which: the special physical nature of the aquifer is introduced; and a marginal analysis technique is included to increase the efficiency of the solution procedure. The case of a single-cell aquifer is analyzed as an example of the proposed approach. The results provide a new quantitative definition of safe yield. (Richmond-Chicago)
W70-06848

UNCONFINED AQUIFER SEEPAGE BY CAPILLARY FLOW THEORY,
Cornell Univ., Ithaca, N.Y.
Rameshwar D. Verma, and Wilfried Brutsaert.
ASCE Proceedings, Journal of the Hydraulics Division, Vol. 96, No. HY6, Paper 7363, p 1331-1342, June 1970. 12 p, 5 fig, 16 ref, append. FWPCA Fellowship No 1-F1-WP-26-266-01 and 02.

Descriptors: *Groundwater movement, *Aquifers, *Numerical analysis, Seepage, Unsaturated flow, Saturated flow, Unsteady flow, Capillary water, Equations.

Identifiers: Finite difference methods.

A numerical scheme is presented to analyze a two-dimensional unconfined aquifer of rectangular cross section to determine the fall of the water table, the water content and the rate of outflow into an adjoining water body which fully penetrates the aquifer. The capillary or unsaturated flow above the water table is considered through the use of Richards' equation. It was found that the problem can be solved by an alternating explicit-implicit finite difference scheme. It has the advantage of being efficient and of being suitable even when the fully saturated flow zone is very small. The unknown position of the seepage surface and the unknown boundary between the saturated and the unsaturated zone constitute a very critical aspect of the calculations. (Knapp-USGS)
W70-06978

GROUNDWATER RESOURCES OF IOWA,
Geological Survey, Iowa City, Iowa; and Iowa State Geological Survey, Iowa City.

W. L. Steinhilber, and P. J. Horick.

In: Water Resources of Iowa, Symposium Proceedings, Iowa Academy of Science at Univ of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, p 29-49, Jan 1970. 21 p, 5 fig, 1 tab, 8 ref.

Descriptors: *Groundwater, *Water resources, *Aquifers, *Iowa, Water yield, Water quality, Water supply, Withdrawal, Stratigraphy, Water wells, Sandstones, Limestones, Alluvium, Hydrogeology, Hydrologic data, Reviews. Identifiers: Hydrogeologic units (Iowa).

A general description is presented of the physical, hydrologic, and water-yielding characteristics of the six principal aquifers in Iowa's groundwater reservoir. The six principal water-yielding rock units in the Iowa reservoir are the surficial deposits, the Dakota Sandstone of Cretaceous age, limestones and dolomites of Mississippian age, limestones and dolomites of Silurian and Devonian age, the Cambrian and Ordovician sandstones and dolomites, and the Dresbach sandstones of Cambrian age. The most consistently productive units are

the Cambrian and Ordovician sandstones and dolomites. Others that are highly productive locally are the alluvium (surficial deposits), the Dresbach and Cretaceous sandstones, and limestones or dolomites of Silurian, Devonian, or Mississippian age where they directly underlie major streams. Stratigraphic and hydrogeologic details are tabulated. (See also W70-06981). (Knapp-USGS)
W70-06984

APPLICATION OF A STATISTICAL ZONATION METHOD TO RESERVOIR EVALUATION AND DIGITIZED-LOG ANALYSIS,
Michigan Univ., Ann Arbor. Dept. of Geology and Mineralogy.

For primary bibliographic entry see Field 07C.
W70-06991

NUMERICAL SOLUTION OF THE BOUSSINESQ EQUATION FOR AQUIFER-STREAM INTERACTION,
Stanford Univ., Calif.

For primary bibliographic entry see Field 02A.
W70-07004

A MEAN VALUE THEOREM IN PORE PRESSURE EVALUATION BY THE METHOD OF IMAGES,

McGill Univ., Montreal (Quebec).
For primary bibliographic entry see Field 04B.
W70-07009

MOIRE PATTERN TECHNIQUES IN GROUNDWATER HYDROLOGY,

Department of Energy, Mines and Resources, Calgary (Alberta). Inland Waters Branch.
For primary bibliographic entry see Field 07A.
W70-07011

GROUNDWATER RESOURCES OF THE LAMBAYEQUE VALLEY, DEPARTMENT OF LAMBAYEQUE, NORTHERN PERU,

Geological Survey, Washington, D.C., and Servicio Cooperativo Interamericano de Irrigacion, Vias de Comunicacion, e Industrias.

Stuart L. Schoff, and Juan Luis Sayan M.

Report available for sale from Superintendent of Documents, U.S. Government Printing Office, Wash, D C 20402. U.S. Geological Survey Water-Supply Paper 1663-F, p F1-F77, 1969. 77 p, 24 fig, 3 plate, 19 tab, 19 ref.

Descriptors: *Groundwater, *Water resources, *Arid lands, Irrigation water, Water yield, Aquifers, Water wells, Water quality, Water sources, Water resources development, Hydrologic data, Data collections, Hydrogeology. Identifiers: Lambayeque (Peru).

Groundwater in the Lambayeque Valley, Peru has been developed mainly for irrigation of sugarcane and rice. The available water, whether in streams or underground, is introduced from the Andean highlands by Rio Chancay. In the northern part of the area wells locally yield water rather freely from strata as deep as 73 m, but elsewhere in the area the strata deeper than 20 m are not very productive. The recharge is sufficient to offset withdrawal at a rate of about 81 million cu m per year. A study of the effect of protracted pumping on yields of wells suggests that the rate of recharge locally, and for a short period, was more than 76,000 cu m per day. A pumping test showed the transmissivity to be about 950 cu m per day per m and the storage coefficient to be about 0.07. Based on these coefficients, the drawdown caused by one well discharging 10 liters per second for 6 months would be only 0.066 m at points 4,000 m distant, but 50 wells at the same rate and distance would create 3.3 m of drawdown. The waters from wells of the Lambayeque Valley compare favorably, in most respects, with the standards established by the U.S. Public Health Service for water for human consumption. The average yield obtained from a meter

of water-bearing stratum has been 6.7 liters per sec in initial pumping tests but only 3.5 liters per sec under steady pumping. The average yield per meter of installed well screen was 4.9 liters per sec in initial tests but declined under steady pumping to 2.5 liters per sec. (Knapp-USGS)
W70-07026

WATER RESOURCES OF THE PINE RIVER BASIN, SOUTHEASTERN MICHIGAN,
Geological Survey, Washington, D.C.
For primary bibliographic entry see Field 07C.
W70-07028

BASIC TRANSPORT COEFFICIENTS AS AQUIFER CHARACTERISTICS,
Water Planning for Israel Ltd., Tel-Aviv.
Y. Bachmat.

French Summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 63-75, 1967. 6 ref.

Descriptors: *Groundwater, *Aquifers, *Aquifer characteristics, Hydrologic properties, Hydrologic equation, Flow characteristics, Mathematical studies, Mathematical models, Probability, Statistical models, Parametric hydrology, Discharge (Water), Porosity, Porous media.
Identifiers: Israel.

A general approach to laminar steady flow of an incompressible homogeneous liquid through an inert and stable porous medium is presented. The analysis is carried out using some probability concepts. It is shown that the mass flow is governed by an algebraic equation of second order with respect to the average specific discharge. The averaged medium parameters, which appear in this equation, are functions of the statistical distributions of the medium's geometric properties in the neighborhood of a point in space. The physical meaning of these parameters is discussed; ways to measure them and to use them as means for classification of aquifers are indicated. (Gabriel-USGS)
W70-07071

APPROACH TO THE PROBLEM OF THE UNDERGROUND WATER LEAKAGE FROM THE STORAGE IN KARST REGIONS, KARST STORAGES BUSKO BLATO, PERUCA AND KRUSICA,

Mladen Borelli, and Boris Pavlin.

French Summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 32-62, 1967. 15 fig, 1 tab, 7 ref.

Descriptors: *Groundwater movement, *Karst, *Groundwater basins, Reservoir leakage, Groundwater, Aquifers, Reservoir storage, Water loss, Water level fluctuations, Geologic formations, Geologic mapping, Hydrogeology, Hydrologic properties, Permeability, Leakage, Frequency analysis. Identifiers: *Yugoslavia.

Analytical and experimental studies were made of three reservoirs in the Yugoslavian Karst region. The analysis was based on the application of statistical methods and on an assumption that a relationship exists between the general hydraulic conditions of fissured rocks and the existence of individual large caverns and channels. The application of statistical analysis for the determination of the zones of high permeability and their variance in depth is of considerable value, although in Karst regions the method leads to very rough estimates. (Gabriel-USGS)
W70-07072

CIRCULATION OF KARSTIC WATERS IN CALCAREOUS COMPLEXES AND ITS QUANTITATIVE BALANCE (IN FRENCH),
Eugen Kullman.

English summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 152-160, 1967. 2 fig, 2 tab, 4 ref.

Descriptors: *Groundwater, *Karst, *Water balance, *Water circulation, Water yield, Hydraulic properties, Water resources, Flow characteristics, Geology, Hydrogeology, Precipitation (Atmospheric), Discharge measurement, Water resources, Water storage.

Identifiers: Czechoslovakia, Carpathians.

Recharge and exhaustion of karstic water reserves of the western Carpathians are described and water-balance calculation are used for the quantitative estimation of the Triassic water resources. The evaluation of the Karst-water balance of this area was based on the knowledge of specific underground flows in the different calcareous complexes and detailed observations of various hydrologic and hydraulic properties. Between 40 and 50% of the underground water of the calcareous complex passes below the geological strata of the plain and the evaluation of his plain's water balance confirms this estimate. Some reliable data are given on specific flow values and water circulation in the various geologic, tectonic, and climatic areas of the western Carpathians. (Gabriel-USGS) W70-07073

EXPLOITATION OF A CAPTIVE KARSTIC AQUIFER DISCHARGING THROUGH SUBMARINE SPRINGS-PROBLEMS ARISING AND SOLUTION ADOPTED LEBANESE COAST (IN FRENCH),

Louis Moulard, Borivoje Mijatovic, Rene Karch, and Bernard Massaad.

English summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 106-119, 1967. 10 fig, 2 tab.

Descriptors: *Hydrologic properties, *Spring waters, *Karst, *Exploitation, Water balance, Water level fluctuations, Water resources, Water sources, Water storage, Water yield, Limestones, Dolomite, Water levels, Velocity, Water analysis, Geochemistry, Pumping.

Identifiers: *Lebanon, Karstic aquifer exploitation.

The aquifers of the Coastal region of North Lebanon, which discharge water to the sea at the rate of 50 cu m/sec were analytically and experimentally investigated. One possibility studied was the invasion of the aquifers by sea water when the pressure is lowered by withdrawal and the other possibility was the tapping of karstic aquifers at the points where underground flow and pressure are favorable to help prevent such invasion. (Gabriel-USGS)

W70-07074

GROUNDWATERS AT THE BASE OF NON-LAMINATED HARD STRATA AND CAVERNS AT THEIR LOWER CONTACT (IN FRENCH), Ernst Sloboda.

English summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 184-189, 1967. 5 fig, 6 ref.

Descriptors: *Groundwater movement, Geology, *Karst, *Water circulation, Aquifers, Limestones, Dolomite, Alluvial channels, Structural geology, Water structure, Water table, Boreholes.

Identifiers: Burgwald (Hesse).

In regions of thick nonlaminated hard rock strata, water of infiltration accumulates in fissures, joints and brecciated zones. If there is a permeable weathered layer, water infiltrates rapidly. The flow of underground water and discharge from springs are both considerable. If the hard strata have undergone tectonic alteration by pressure and ten-

sion, karst phenomena are encountered even in compacted sandstones, as in the neighborhood of the Burgwald in Hesse. In calcareous terrains, karst problems are satisfactorily known, but there is little knowledge of the importance of the base zone of compacted nonlaminated beds, where, particularly in the synclines, tectonic action opens diques. In this zone the water forms a system of caverns along the lower contact of the inclined beds. Examples are to be found in Iran, Sicily, Tunisia and Yugoslavia. This is difficult country for dam building, but it does carry water down to the depths rapidly and recharges the artesian reservoirs with relatively cold water. (Gabriel-USGS) W70-07075

HYDROLOGICAL AND HYDRAULIC CHARACTERISTICS OF WATERS FLOWING FROM FISSURED CARBONATED ROCKS INTO MINES,

Dorog Coal Mining Trust (Hungary).

T. Tettamanti.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 106-119, 1967. 10 fig, 2 tab.

Descriptors: *Groundwater, *Aquifers, *Hydrologic properties, Flow measurement, Flow characteristics, Geology, Fissures (Geology), Groundwater basins, Pumping, Mine water, Mine drainage, Hydrodynamic, Hazards, Well casings, Acidic water, Dam construction.

Identifiers: *Hungary, Coal mine hydrology.

Hydrologic and hydraulic characteristics of water flows present in the Karstic and fractured zones of carbonaceous formations in the Metalliferous areas of the Transdanubian Range were investigated on the basis of water-pumping and water-level data observed in several mines. Some methods of protection against water were also investigated. (Gabriel-USGS) W70-07076

ANALYSIS OF PUMPING TEST IN FRAC-TURED ROCKS,

Egyptian Desert Inst., Cairo.

Nabil Rofail.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 81-88, 1967. 4 fig, 1 tab, 4 ref.

Descriptors: *Groundwater movement, Aquifers, *Hydraulic properties, *Flow characteristics, Mathematical studies, Mathematical models, Fissures (Geology), Transmissivity, Piezometry, Diffusivity, Aquifer characteristics, Hydrologic equation, Geology, Porous media, Porosity.

Identifiers: Aquifer testing, Nile Delta, Egypt.

The constants of fissured aquifer formations were analytically investigated by using the Kothe-Kochina equation of radial flows and assuming that the flow takes place through a medium of double porosity that is, matrix porosity and the porosity of the fissures. Transmissivity, piezometric diffusivity and a new specific constant characterizing the size of fissures were taken as hydraulic constants. After setting a differential equation for pumping at constant rate, the equation was solved and the formation constants were determined by using curve type methods. Drawdown distribution was also evaluated and given in a tabular form for small time values. (Gabriel-USGS) W70-07077

EFFECT OF IMPERVIOUS BARRIERS OF DEEP-SEALED FRACTURES ON GROUND-WATER FLOW,

Egyptian Desert Inst., Cairo.

Kamal F. Saad.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 76-80, 1967. 2 fig, 2 append.

Descriptors: *Aquifers, *Groundwater movement, *Aquifer characteristics, *Hydraulic properties, Transmissivity, Storage, Storage coefficient, Fractures (Geology), Flow characteristics, Fissures (Geology), Permeability, Steady flow, Water storage, Groundwater barriers, Water wells, Mathematical studies.

The hydraulic properties of an aquifer that is partially opposed by a barrier are analytically investigated by assuming the concept of an unsteady radial flow toward a water well and using the theory of images. It is also assumed that the water well is located near a fault which partially opposes the ground water flow and that the amount of fault displacement may be estimated. By plotting an analytical parameter (m) versus time, the inflection point of this curve can be found and the transmissivity and storage capacity of an aquifer can be determined. (Gabriel-USGS) W70-07078

PROBLEM OF THE DEMARCTION OF DRAINAGE BASINS AND DIRECTIONS OF FLOW OF UNDERGROUND STREAMS IN THE DINAR KARST (IN FRENCH),

Institute for Geological and Geophysical Research, Belgrade (Yugoslavia).

Miomir Komatina.

English summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 190-199, 1967. 8 fig, 4 ref.

Descriptors: *Groundwater movement, *Karst, *Water circulation, Hydraulic systems, Groundwater, Groundwater basins, Hydrogeology, Geomorphology, Geology, Fissures (Geology), Faults (Geology), Limestones, Dolomite, Water sources.

Identifiers: Dinaric Alps, Yugoslavia.

Karstic drainage basins of the Dinaric Alps were investigated with special attention given to the study of fracturing in carbonate rocks as a leading factor for the development of zones of Karstification. The study confirms the value of geologic and hydrologic data and the value of reliable mapping of fissure zones for the demarcation of groundwater zones and determination of groundwater-flow directions. (Gabriel-USGS) W70-07079

RESEARCH IN THE BOETIAN KARSTIC LAKES REGION (IN FRENCH), G. G. Mistardis.

English summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 162-170, 1967. 3 fig, 13 ref.

Descriptors: *Groundwater, *Karst, *Hydrologic properties, Hydrologic data, Hydrologic aspects, Geology, Lake basins, Tunnels, Drying, Engineering structures, Water resources, Erosion, Topography, Climatic zones, Forecasting, Water level fluctuations.

Identifiers: *Greece, Boetia.

The hydraulic history and the geological and hydrological conditions of the Karstic lakes region of Boetia, Greece are outlined. Even after the draining of Lake Copais in 1892, the Karstic springs continued to be abundant, indicating that an important Karstic water network exists in the deeper part of the region. The origin of these Karstic networks and the level fluctuations of the lakes, beginning with Pliocene epoch, are also discussed. (Gabriel-USGS) W70-07080

Field 02—WATER CYCLE

Group 2F—Groundwater

THE HYDRAULIC PROPERTIES AND YIELD OF DOLOMITE AND LIMESTONE AQUIFERS, Illinois State Water Survey, Urbana.

Sandor C. Csallany.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 120-138, 1967. 14 fig, 9 ref.

Descriptors: *Illinois, *Aquifers, *Hydraulic properties, *Water resources, Dolomite, Limestones, Aquifer characteristics, Groundwater, Water wells, Test procedures, Geology, Fissures (Geology), Transmissivity, Porosity, Permeability, Storage capacity.

Identifiers: *Carbonate rock aquifers, *Aquifer testing.

In Illinois large quantities of groundwater are withdrawn from wells in dolomite and limestone wells of Mississippian, Silurian, and Ordovician age. About 1,250 well production tests were made on more than 1,000 wells. During aquifer tests interference between wells spaced more than one-half mile apart was measurable, indicating that water-yield openings in rocks extend for considerable distances. The dolomite and limestone contains numerous interconnected fractures and crevices. The controlled pumping test method may describe the hydraulic properties of the dolomite and limestone on an areal basis, but does not accurately describe the drawdown in the immediate vicinity of a pumped well. Statistical analysis of adjusted specific capacity data is probably the best method to determine the yields of wells on an individual and regional basis because of the interconnection of fractures and inconsistency in yields. Rough estimates were made of the coefficients of transmissibility of the shallow dolomite based on average specific capacity data. The probable ranges in yields of dolomite and limestone wells in undeveloped areas are estimated from specific capacity frequency graphs, aquifer thickness and areal geology maps, and water level data. (Gabriel-USGS)

W70-07082

WATER BALANCE INVESTIGATIONS IN THE KARSTIC REGIONS OF HUNGARY,

Research Inst. for Water Resources Development, Budapest (Hungary).

H. Kessler.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 91-105, 1967. 6 fig, 2 photo, 4 ref.

Descriptors: *Groundwater movement, *Aquifers, *Water balance, *Karst, Precipitation (Atmospheric), Water circulation, Water levels, Water measurement, Water sources, Water supply, Water demand, Mine drainage, Infiltration, Forecasting, Wells, Geology.

Identifiers: *Hungary.

Precipitation, water levels, annual yields of springs, and other pertinent data recorded in the Karstic regions of Hungary for a number of years are analyzed. The investigation was based on a principle that the knowledge of hydraulic and hydrologic patterns of a Karstic area should lead to a correct estimate of the size of its catchment and its dynamic water supply on the basis of the annual yields of springs. To observe water levels, observation wells have also been located in areas subject to artificial interventions such as mining. A significant increase in the Karstic water levels and, in consequence, the accumulation of dynamic water supplies takes place in the first four months of the year, as a result of snowmelts. Flow velocities (50-150 m/hour), observed in the course of this study demonstrate the relationship between swallows and karstic springs. (Gabriel-USGS)

W70-07083

KARST HYDROGRAPHY (IN FRENCH),

Franc Jenko.

English summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 172-182, 1967. 5 fig.

Descriptors: Hydrography, *Karst, *Hydrographic analysis, *Groundwater, Geology, Hydrologic properties, Aquifers, Aquifer characteristics, Geochemistry, Geophysics, Dolomite, Limestones, Water table, Water balance, Water level fluctuations, Water resources, Water sources, Carbon dioxide, Velocity, Water wells.

Identifiers: Yugoslavia.

The hydrography of a typical Karstic area is described on the basis of numerous earlier publications. The use of bores and geophysical methods in Karstic terrains reveal the presence of undulating water tables separated horizontally and vertically at various depths. Stream often rise in relatively impermeable formations and then flow over the surface or in underground channels. It is also suggested that aquifers associated with undulating water tables carry very large water reserves down to great depths. Some hydromechanical principles of Karstic waters in contact with sea waters are also explained. (Gabriel-USGS)

W70-07084

GROUNDWATERS AND CHANNELS OF KARST AREAS (IN FRENCH),

Consejor Superior di Investigaciones Cientificas, Madrid (Spain). Dept. of Hydrogeology.

H. Llopin Llado.

Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 200-203, 1967. 3 fig.

Descriptors: *Groundwater movement, *Karst, *Water circulation, *Channel flow, Geology, Permeability, Limestones, Dolomite, Aquifers, Marl, Conglomerate rocks, Porosity, Fissures (Geology), Fissures (Geology).

Identifiers: Island of Majorca, Spain.

The effect of fissures in calcareous rocks on water circulation was investigated on the basis of geological and hydrological data obtained in the Lleida calcareous massif of Majorca. The aquifer circulation of a karstic groundwater reservoir is usually well developed in folded regions or where the fissure density is well developed. The existence of initial sedimentary porosity also favors the development of aquifer circulation. Channel circulation, however is very common in calcareous complexes which are slightly tectonized. (Gabriel-USGS)

W70-07085

HYDRODYNAMIC ZONING OF KARST WATER,

Gosudarstvennyi Geologicheskii Institut, Lenigrad (USSR).

D. S. Sokolov.

Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 204-207, 1967.

Descriptors: *Groundwater, *Karst, *Water circulation, Hydrodynamics, Water levels, Water level fluctuations, Flow characteristics, Climates, Fissures (Geology), Geochemistry, Diffusion, Permeability, Aeration, Drainage, Soil physical properties.

Identifiers: *Hydrodynamic zoning.

A scheme of vertical hydrodynamic zoning of karst waters accumulated in the thick strata of carbonate and sulfate rocks is outlined. This scheme consists of four vertical zones with their characteristic movements and other conditions. The first zone of aeration is characterized by the descending water movements of infiltration and inflow; the so-called suspended karstic waters are also in this zone. The second zone is the zone of seasonal fluctuations of karstic waters. The third zone is the zone of full

saturation where the drainage is governed by the local drainage network underground. The fourth or the last zone is the zone of deep circulation where groundwaters move in the direction of remote outlets and where there is no direct influence of local drainage. (Gabriel-USGS)

W70-07086

NONSTEADY FLOW TO A WELL IN AN INFINITE ANISOTROPIC AQUIFER,

Geological Survey, Washington, D.C.

Istravros S. Papadopoulos.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 21-31, 1967. 5 fig, 1 tab, 6 ref.

Descriptors: *Groundwater movement, *Aquifers, *Water level fluctuations, Anisotropy, Isotropy, Hydrologic data, Hydrologic properties, Water wells, Transmissivity, Analysis, Mathematical studies, Mathematical models, Discharge (Water), Discharge measurement, Analog models.

Identifiers: *Aquifers testing, Pumping tests (Aquifers).

Well flow equations presently used in the analysis of pumping tests and the prediction of water levels have been derived under the assumption that aquifers are isotropic. These existing equations are not applicable to anisotropic aquifers such as fractured rocks. In this paper, an equation is derived for the drawdown distribution around a well discharging at a constant rate from an infinite anisotropic aquifer. Drawdowns computed by this equation are compared and found to be in good agreement with those observed in an electric-analog model constructed for this purpose. It is shown that pumping test data from a minimum of three observation wells can be analyzed to obtain the components of the transmissibility tensor along an arbitrarily chosen set of axes, and that these components, in turn, can be used to determine the principal transmissibilities and the orientation of the principal axes. The method is illustrated with an example. (Gabriel-USGS)

W70-07087

STATISTICAL ASPECT OF THE PROBLEM OF PERMEABILITY OF FISSURED ROCKS,

M. V. Rats, and S. N. Chernyashov.

French summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 227-236, 1967. 5 fig, 1 tab.

Descriptors: *Statistical methods, *Statistical models, *Aquifers, *Permeability, *Joints (Geology), *Fissures (Geology), Mathematical studies, Parametric hydrology, Heterogeneity, Homogeneity, Geographical regions, Deformation, Erosion, Sandstones, Igneous rocks, Probability, Karst, Geology.

Identifiers: Jointed rocks.

The physical laws governing the distribution and homogeneity fissures and permeability in rocks were investigated statistically. Mathematical criteria were applied to separate the homogeneous and heterogeneous media and to set limits for the application of permeability concepts. Several examples of the application of statistical methods for the analysis of fissures and permeability parameters are given over wide geographical and geological ranges. (Gabriel-USGS)

W70-07088

THE EFFECT OF KARST ON THE REGULARITIES OF GROUNDWATER FLOW FORMATION,

Moscow State Univ. (USSR).

B. I. Koudelin, and V. P. Karpova.

Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), Interna-

tional Association of Scientific Hydrology, Publication No 73, p 208-212, 1967.

Descriptors: *Groundwater, *Karst, *Water circulation, Flow characteristics, Topography, Dolomite, Limestones, Erosion, Runoff, Geology, Absorption, Hydrologic properties, Streamflow, Rivers, River basins, Hydrographs, Hydrograph analysis.

Identifiers: *USSR, Urals, Crimea.

A brief review is given of the characteristics of groundwater flows in the karstic regions of the USSR. Karst leads to the intensification of a groundwater flow. Karst interrupts the smooth zonal character of the distribution of groundwater and flow values of the area. Wide fluctuations of groundwater flow and surface runoff are observed within karstic regions. Karst leads to the redistribution of groundwater flows into rivers within relatively small areas. The large values of the moduli and coefficients of groundwater flow and base flow in karstic regions are due not only to highly favorable conditions for precipitation absorption and surface runoff by karstic rocks, but also to the peculiar features of the karstic water regime noted for its vigorous, turbulent and rapid groundwater movement. The type of groundwater flow in karstic massifs is often similar to that of a streamflow regime. Karstic rock massifs are noted for relatively limited water storage, as compared with poorly-indurated rocks. (Gabriel-USGS)

W70-07089

HYDROLOGY OF SEBOU-BETH KARSTIC ZONE OF MOROCCO (IN FRENCH),

Water Resources Service (Morocco).

R. Hazan, and D. Lazarevitch.

English summary. Hydrology of Fractured Rocks, Proceedings of Dubrovnik Symposium (October 1965), International Association of Scientific Hydrology, Publication No 73, p 275-292, 1967. 12 fig, 1 tab.

Descriptors: *Karst, Hydrologic properties, *Groundwater basins, Runoff, Drainage, Permeability, Geology, Fissures (Geology), Floods, Average flow, Water resources, Sediment transport, Precipitation (Atmospheric), Hydrography, Water storage, Electric power, Silting.

Identifiers: *Morocco, Sebou-Beth basins.

Hydrologic characteristics of the Sebou-Beth karstic and impermeable basins were investigated on the basis of geological and hydrological data recorded from 1935 to 1963. Evapotranspiration plays an important part in the karstic Sebou-Beth basin by controlling to some extent the annual discharge, runoff, and groundwater runoff; the karstic zone plays the role of a dam and a reservoir. It is suggested that the use of hydroelectric power may be considered to have promise. (Gabriel-USGS)

W70-07090

THE BASIC HYDROLOGIC CHARACTERISTICS OF THE KARST RIVER LJUBLJANICA,

Hydrometeorological Inst., Ljubljana (Yugoslavia).

For primary bibliographic entry see Field 02E.

W70-07091

2G. Water in Soils

CHEMICAL CONTAMINANTS FOUND IN SURFACE AND SUBSURFACE WATER AS RELATED TO SOIL AND CLIMATIC CONDITIONS,

Maine Univ., Orono.

For primary bibliographic entry see Field 05A.

W70-06756

AN OSMOTIC METHOD FOR STUDYING THE SUCTION/MOISTURE CONTENT RELATIONSHIPS OF POROUS MATERIALS,

Rothamsted Experimental Station, Harpenden (England).

D. T. Pritchard.

Journal of Soil Science, Vol 20, No 2, p 374-383, September 1969. 10 p, 10 fig, 9 ref.

Descriptors: *Osmosis, *Moisture content, *Moisture tension, Soil water movement, Porosity, Permeability, Soil structure, Porous media, Membranes, Osmotic pressure.

Identifiers: Moisture content-tension relations.

Zur's osmotic method was simplified by placing 2 g particulate samples in 6.5 mm diam sacs made of semipermeable membrane tubing and suspending these in solutions of polyethylene glycol (PEG), molecular weight approx. 20,000. Moisture content was measured daily by weighing the sacs. PEG solutions of low pF were calibrated by hanging sacs containing water in them, and observing the difference in height of the liquid surfaces at equilibrium. The range was thus extended from pF 3.0-4.2 to pF 1.5-4.1. Wetting over the whole range takes 8 days and drying, from saturation, 16 days. Six polythene boxes (each holding 3.25 liter of PEG) used simultaneously, give the equivalent of wetting curves for 24 samples per day. In the isopiestic method, used for comparison over the range pF 3.5-4.0, nickel crucibles containing 1 g samples were partly immersed in control solutions of sodium chloride, in vacuum desiccators, in a temperature controlled double water-bath. (Knapp-USGS)

W70-06768

A STEADY-STATE METHOD FOR DETERMINING DIFFUSION COEFFICIENTS IN SOIL,

Oxford Univ. (England). Soil Science Lab.

P. B. Tinker.

Journal of Soil Science, Vol 20, No 2, p 336-345, September 1969. 10 p, 4 fig, 1 tab, 15 ref.

Descriptors: *Diffusivity, *Cations, *Soil chemistry, Ion transport, Soil chemical properties, Laboratory tests, Ion exchange, Electrolytes.

Identifiers: Soil diffusivity.

A simple method for determining steady-state diffusion coefficients of cations in soil with cation exchange papers as sources and sinks may be used at a range of moisture contents. It was tested on the inter-diffusion of Ca and Mg in a Coral Rag clay soil. Sectioning and analysis of the soil after the steady state was reached gave a plot of composition with distance along the cell which was similar to the curved Ca-Mg exchange isotherm, and indicated that nearly all the flux was through the liquid phase. Values of the tortuosity factor could therefore be found. There were indications that bicarbonate ions were formed and increased the flux in some experiments. Transient-state diffusion coefficients were measured in the same experiments, and agreed fairly well with the steady-state results. (Knapp-USGS)

W70-06769

EFFECTS OF ADSORBED CATIONS ON PHYSICAL PROPERTIES OF TROPICAL RED EARTHS AND TROPICAL BLACK EARTHS: I. PLASTIC LIMIT, PERCENTAGE STABLE AGGREGATES, AND HYDRAULIC CONDUCTIVITY,

Hawaii Agricultural Experiment Station, Honolulu. S. Ahmed, L. D. Swindale, and S. A. El-Swaify.

Journal of Soil Science, Vol 20, No 2, p 255-268, September 1969. 14 p, 3 fig, 4 tab, 24 ref.

Descriptors: *Soil chemistry, *Soil structure, *Hydraulic conductivity, *Electrolytes, *Clay minerals, Sodium, Potassium, Calcium, Magnesium, Water chemistry, Soil chemical properties, Soil texture, Soil types, Plasticity, Atterberg limits, Hawaii.

Identifiers: Tropical soils.

Similar relative effects were obtained for plastic limits, percentage stable aggregates, and hydraulic conductivities when a tropical red earth, consisting predominantly of kaolin and iron oxide, and a tropical black earth consisting predominantly of montmorillonite, were saturated with Ca, Mg, K, or Na ions or combinations of these. Plastic limits were independent of the nature of the saturation cations, but were significantly dependent upon clay type. Percentage stable aggregates of artificially prepared aggregates and hydraulic conductivity were affected by the 4 cations in the order Ca Mg K Na and were also significantly affected by clay type. Combinations of the 4 cations generally gave intermediate effects with Ca-saturated soils more susceptible to deterioration by K or Na than Mg-saturated soils. The results confirm the generally deleterious effect of Na ions and show that K ions have effects similar to Na on the properties investigated. They suggest that heavy potash fertilization without liming may lead to structural deterioration of these soils. (Knapp-USGS)

W70-06771

INFLUENCE OF GRAVEL LAYERS ON SOIL MOISTURE CONTENT AND FLOW,

Du Pont de Nemours (E. I.) and Co., Aiken, S.C. Savannah River Lab.

John C. Corey, and J. Henry Horton.

Available from Clearinghouse as DP-1160 at \$3.00 in paper copy and \$0.65 (microfiche). Savannah River Laboratory Report DP-1160, E. I. Du Pont De Nemours and Co., Aiken, S.C., May 1969. 23 p, 9 fig, 10 ref. USAEC Contract AT (07-2)-1.

Descriptors: *Leaching, *Soil water movement, *Percolation, *Path of pollutants, *Radioactive waste disposal, Silts, Sands, Gravels, Radioactive wastes, Groundwater movement, Saturated flow, Unsaturated flow, Laboratory tests, Model studies, Hydraulic models, Waste disposal.

Identifiers: Gravel lenses.

Three experiments were used to determine the influence of a gravel lens on soil water near the lens and the flow paths taken by the water. Gravel lenses cannot divert percolating rainwater 2 meters during periods of prolonged rain. Four-meter diversions would be required to protect solid radioactive waste contained in large burial trenches. However, the existence of diversion suggests that the contaminated interiors of individual pipes and vessels in such trenches are immune to leaching. The small openings in this equipment permit the diversion of percolating water around the vessel as long as the interior of the vessel remains free of soil. Laboratory studies of infiltration, drainage, and rewetting confirmed that sandy loam and sandy clay soil have a greater capacity to hold water when they are above a gravel layer. After drainage, 85 cm of soil can retain water equal to or greater than the precipitation that infiltrates during an average rain. (Knapp-USGS)

W70-06779

UTILIZATION AND MANAGEMENT OF WATER IN THE ARID ZONES OF MEXICO (IN SPANISH),

Instituto Tecnologico y de Estudios Superiores de Monterrey (Mexico). Departamento de Suelos e Irrigacion.

For primary bibliographic entry see Field 02I.

W70-06825

AN EXPERIMENTAL INVESTIGATION OF RUNOFF PRODUCTION IN PERMEABLE SOILS,

McGill Univ., Montreal (Quebec).

Thomas Dunne, and Richard D. Black.

Water Resources Research, Vol 6, No 2, p 478-490, April 1970. 13 p, 10 fig, 4 tab, 12 ref.

Descriptors: *Rainfall-runoff relationships, *On-site tests, *Model studies, *Subsurface runoff, *Overland flow, Infiltration, Groundwater movement, Soil water movement, Simulated rainfall, Antecedent precipitation.

Identifiers: Experimental watersheds.

Field 02—WATER CYCLE

Group 2G—Water in Soils

In an area of low intensity rainfall and permeable soils, three hillside plots were instrumented for a study of runoff-producing mechanisms. Runoff from the plots was measured at the ground surface, the base of the root zone, and in the zone of perennial groundwater seepage. Data on soil moisture, water-table elevation, and piezometric head were collected during both natural and artificial storms. When the infiltration capacity of the soil exceeded the rainfall intensities, overland flow did not occur. Although soils and topography were those generally thought to be conducive to subsurface stormflow, the runoff produced by this mechanism was too small, too late, and too insensitive to fluctuations of rainfall intensity to add significantly to stormflow in the channel at the base of the hillside. When the water table rose to the surface of the ground, overland flow was generated on small areas of the hillside. Only when this overland flow occurred were significant amounts of stormflow contributed to the channel by the hillside. The return periods of storms that would produce such overland flow were found to be very large. (Knapp-USGS)
W70-06996

OBSERVATIONS ON THE GROWTH OF NEEDLE ICE,

Canterbury Univ., Christchurch (New Zealand).
For primary bibliographic entry see Field 02C.
W70-07005

COMPARISON OF SOLUTIONS OF A NON-LINEAR DIFFUSION EQUATION,

Cornell Univ., Ithaca, N.Y.
Wilfried Brutsaert, and Richard N. Weisman.
Water Resources Research, Vol 6, No 2, p 642-644, April 1970. 3 p, 1 fig, 1 tab, 7 ref.

Descriptors: *Diffusion, *Equations, *Mathematical studies, Mathematical models, Infiltration, Percolation, Numerical analysis:
Identifiers: Nonlinear diffusion.

Four solutions of a general nonlinear diffusion equation are given. A numerical analysis serves as reference for one series solution and for two more simple approximate solutions. The accuracy of the methods is discussed and presented graphically; the results of the numerical analysis are given in tabular form. It was found that the usefulness of the two approximate solutions lies in their mathematical simplicity and the accuracy with which they describe infiltration. (Knapp-USGS)
W70-07010

A MODEL OF SURFACE CRUSTING AND INFILTRATION OF BARE SOILS,

Technion - Israel Inst. of Tech., Haifa; and Ministry of Agriculture.
Ido Seginer, and Joseph Morin.
Water Resources Research, Vol 6, No 2, p 629-633, April 1970. 5 p, 6 ref.

Descriptors: *Infiltration, *Impact (Rainfall), *Soil compaction, *Permeability, *Mathematical models, Soil structure, Soil moisture, Soil water movement, Soil surfaces, Surface sealing.
Identifiers: Soil surface crusting.

An infiltration equation was derived on the assumption that a drop upon impact with the soil compacts a small area. The size of this area is characteristic of the drop and the soil properties. Extensions of this model can treat spectrums of drops and variations of rainfall characteristics with time. The model applies to initially saturated homogeneous soil columns and leads to the conclusion that the reduction of infiltration capacity is not directly related to time but rather to the number of drops that hit the surface. The effect of the depth of the soil column on the final infiltration capacity is such that the deeper it is, the higher the final infiltration capacity, approaching a limit, which depends on the properties of the crust, not of the subsoil. It is suggested that comparisons between infiltration experiments in columns be made on the

basis of the intrinsic value of the limiting infiltration capacity. (Knapp-USGS)
W70-07012

SOIL MOISTURE IN RELATION TO VEGETATION DISTRIBUTION IN THE MOUNTAINS OF NORTHERN IDAHO,

Washington State Univ., Pullman.
R. Daubenmire.
Ecology, Vol 49, No 3, p 431-438, Late Spring 1968. 3 fig, 2 tab, 13 ref.

Descriptors: *Soil moisture, *Vegetation, *Ecological distribution, *Mountains, *Idaho, Slopes, Altitude, Environmental effects, Distribution patterns, Soil-water-plant relationships, Soil water, Climatic zones, Habitat, Biomes, Terrestrial habitats, Moisture stress, Moisture deficit, Succession, Climax, Growth stages, Drought tolerance, Plant physiology, Aestivation, Xerophytes, Arid lands, Semiarid climates, Pine trees, Fir trees, Fescues, Wheatgrasses.

Identifiers: *Vegetation zones, *Soil drought, *Soil moisture regimes, Growth water.

Studies in northern Idaho showed that in summer soil drought was earliest and most intense on basal plains of mountains, but intensity decreased in higher forest associations. This would appear to substantiate previous data indicating that above a certain point in the synecologic series, soil drought is of minor importance in explaining community differentiation. Climax vegetation dominated by Douglas-fir, ponderosa pine, Idaho fescue, or bearded bluebunch wheatgrass suffered regular and severe soil drought. In contrast, climax species such as alpine fir, Pacific hemlock, and giant arborvitae showed little or no soil drought at season of maximum dryness. However, in densely forested mesophytic areas, the early stages of secondary succession were occasionally characterized by intense soil drought. Also, fescue and wheatgrass were found on high forested mountain slopes in local areas of soil drought similar to their habitat in the basal plains. These data for northern Idaho show clearly that soil moisture conditions can be predicted more reliably from climax conditions of vegetation types than by elevation above sea level. (Carr-Arizona)
W70-07051

2H. Lakes

DISTRIBUTION OF MAJOR, MINOR, AND TRACE CONSTITUENTS IN UNCONSOLIDATED SEDIMENTS FROM SOUTHERN LAKE MICHIGAN,

Illinois State Geological Survey, Urbana.
For primary bibliographic entry see Field 02J.
W70-06748

LAKESHORE TWO-DIMENSIONAL DISPERSION,

Ontario Water Resources Commission, Toronto.
Great Lakes Water Quality Surveys Program.
M. D. Palmer, and J. B. Izatt.
Ontario Water Resources Commission, Canada
Great Lakes Surveys Program, March 26, 1970. 29 p, 11 fig, 5 tab, 9 ref.

Descriptors: *Lakes, *Currents (Water), *Dispersion, Markov processes, Stochastic processes, Instrumentation, Current meters, Great Lakes, Diffusion, Dye releases, Tracking techniques, Statistical methods.

Identifiers: Lakeshore dispersion.

Hourly two-dimensional dispersion characteristics are determined from recording current meter histories for the nearshore areas on Lake Erie and Lake Ontario. The current histories were obtained in areas within 4 km of shore and at water depths of 10 to 14 meters during May to November 1968. A Markov chain process was applied to hourly current readings. Three different formulations of the

stochastic process were tested prior to the selection of the most reliable one. The results obtained in applying the developed technique compare favorable with results obtained from conventional dye injection and drogue studies. (Knapp-USGS)
W70-06762

AN ANALYSIS OF CURRENT MEASUREMENTS IN LAKE MICHIGAN,

New York Univ., Bronx. Geophysical Sciences Lab.; and Columbia Univ., Dobbs Ferry, N. Y. Hudson Labs.

Frank D. Malone.

Journal of Geophysical Research, Vol 73, No 22, p 7065-7081, November 15, 1968. 17 p, 13 fig, 3 tab, 23 ref. ONR Contracts PH86-66-17, Contract Nonr 285 (57) and Nonr 266 (84).

Descriptors: *Currents (Water), *Lake Michigan, *Statistical methods, *Data processing, Frequency analysis, Fourier analysis, Lakes, Limnology, Water circulation.

Identifiers: Spectral analysis, Cross-spectral analysis.

Current meter records, collected from Lake Michigan during the Great Lakes-Illinois River Basins project, are studied using harmonic, spectral, and cross-spectral analysis techniques. Major peaks in the velocity spectra are located near the local inertial frequency during the thermocline season. Cross-spectra between the velocity components at different depths yield high coherences (0.9) near the inertial frequency and show that the velocity components are approximately 180 deg out of phase above and below the thermocline. The current meter records from the mouth of Green Bay and the Straits of Mackinac are dominated by periods of 12 and about 50 hours, respectively. (Knapp-USGS)
W70-06794

CHEMICAL CHARACTERISTICS OF LAKE ONTARIO,

Bureau of Commercial Fisheries, Ann Arbor, Mich. Biological Lab.

For primary bibliographic entry see Field 02K.

W70-06966

PHYTOPLANKTON,

Freshwater Biological Association, Ambleside (England).

J. W. G. Lund.

Eutrophication: Causes, consequences, correctives, p 307-330. Printing and Publishing Office, National Academy of Sciences, Washington, DC, 1969. 4 fig, 2 tab, 45 ref.

Descriptors: *Phytoplankton, Eutrophication, Nutrients, Diatoms, Phosphates, Nitrates, Silicates, Chlamydomonas, Fertilizers, Cyanophyta, Turbidity, Color, Chlorophyta, Sewage, Meromixis, Lakes, Stratification.

Identifiers: Asterionella formosa, Aphanizomenon flos-aquae, Cyclotella pseudostelligera, Staurastrum chaetoceros, Fragilaria crotonensis, Anabaena solitaria, Stephanodiscus hantzschii, Achmanthes, Nitzschia, Synechocystis, Oscillatoria, Cryptomonas, Ceratium, Algal blooms, Lake Windermere (England), English Lake District.

Supportive data indicate that stratification of lakes similar to England's Windermere is advantageous in reducing algal problems. Lake nutrients are lost in deposits, outflow or recycled; the vital factor in eutrophication is the contribution of nutrients from the drainage area. Production of a permanent hypolimnion, is advocated to reduce fertility in meromictic lakes, assisted with the use of flocculants and adsorbents; the material so removed would be retained in the hypolimnion as the stronger the meromixis the lower quantity of nutrients will be recycled when thermal stratification breaks down. In contrast to this view, the experience of the Metropolitan Water Board of London is cited, when reservoirs had their potential

summer stratification reduced by jet-type inlets or axial flow pumps. Overturning a lake in summer results in lesser algal production, judged by transparency and absence of blooms. (See also W70-03975). (Auen-Wisconsin)
W70-06976

NEW SMALL LAKE LAW--OPEN SPACE AND RECREATION VERSUS FILLING AND BUILDING,

For primary bibliographic entry see Field 06E.
W70-07103

II. Water in Plants

WATER USE, ADAPTABILITY, AND CHEMICAL COMPOSITION OF GRASSES SEEDED AT HIGH ELEVATIONS,

Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
For primary bibliographic entry see Field 03B.
W70-06775

NUTRIENT LOSS ACCELERATED BY CLEAR-CUTTING OF A FOREST ECOSYSTEM,

Yale Univ., New Haven, Conn.; Dartmouth Coll., Hanover, N. H.; Geological Survey, Washington, D. C.; and Forest Service (USDA), Durham, N. H.
For primary bibliographic entry see Field 04C.
W70-06796

SURVIVAL OF WINTER ANNUALS IN THE NORTHERN MOJAVE DESERT,

California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology.
Janice C. Beatley.
Ecology, Vol 48, No 5, p 745-750, Late Summer 1967. 3 tab, 15 ref.

Descriptors: *Desert plants, *Deserts, *Nevada, *Soil moisture, *Mortality, Arid climates, Arid lands, Xerophytes, Environment, Moisture deficit, Germination, Plant growth, Growth stages, Vegetation establishment, Mature growth stage, Life cycles, Winter, Precipitation (Atmospheric), Soil-water-plant relationships.

Identifiers: *Annuals, *Seedlings, *Mojave Desert, Moisture regime, Stem elongation, Growing season, Plant survival, Seedlings.

In 1963-64 the population of Mojave Desert winter annuals in three southern Nevada drainage basins was sampled following early autumn germination. Only 38% of the plants survived to maturity, with death occurring in the early spring at beginning of stem elongation. Although the data showed no pronounced precipitation deficiency during the growing season, plant mortality appeared to be the result of insufficient soil moisture. Due to the rapid increase in plant volume at this period, water demands of all seedlings could not be met. In 1965 mortality of spring-germinating winter annuals was studied. Survival to maturity was much higher (60%) for these plants with their shorter life cycle than for the fall-germinating species. Plant mortality for the spring-germinating population was not attributable to moisture deficit. It would appear that in most seasons the majority of winter annual seedlings do not survive to maturity. (Carr-Arizona)
W70-06808

ARTIFICIAL SELECTION FOR SEEDLING DROUGHT TOLERANCE IN BOER LOVEGRASS (ERAGROSTIS CURVULA NEES),

Arizona Univ., Tucson. Dept. of Agronomy; and Agricultural Research Service, Tucson, Ariz. Crops Research Div.
L. Neal Wright, and Gilbert L. Jordan.
Crop Science, Vol 10, No 1 p 99-102, January-February 1970. 1 fig, 2 tab, 5 ref.

Descriptors: *Range grasses, *Forage grasses, *Drought tolerance, *Crop response, Environment, Environmental effects, Moisture stress, Moisture deficit, Growth chambers, Grasses, Arid lands, Semiarid climates, Southwestern U.S., Arizona, On-site investigations, Frequency analysis.

Identifiers: *Boer lovegrass, *Lehmann lovegrass, *Artificial selection, *Seedling drought tolerance, *Survival rates, Stand density.

A program-controlled environment was used for artificial selection and study of 16 sources of boer lovegrass. The plants were stressed for seedling drought tolerance and the progeny of the surviving 216 plants were evaluated. Experimental 3-17, which showed three times the drought tolerance of check cultivar A-84, had a significantly higher survival rate than other selections. The extreme selections were re-evaluated under artificial conditions but the relative rankings did not change. Experimental 3-17, check cultivar A-84, and A-68 lehmann lovegrass were then grown in their natural environment. The rangeland seeding tests took place in southeastern Arizona in 1967 and 1968. Experimental 3-17 obtained a stand density equal to that of lehmann lovegrass and superior to that of the check cultivar. These studies indicate that controlled environments can be used for the consistent evaluation and selection of seedlings. (Carr-Arizona)
W70-06809

MEDITERRANEAN ECOSYSTEMS AND VEGETATION TYPES IN CALIFORNIA AND ISRAEL,

Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
Z. Naveh.
Ecology, Vol 48, No 3, p 445-459, Late Spring 1967. 7 fig, 4 tab, 50 ref.

Descriptors: *Ecosystems, *Environmental effects, *Environment, *California, *Semiarid climates, Grasslands, Plant groupings, Vegetation establishment, Climates, Climatic zones, Geographical regions, Climatic data, Succession, Invasion, Soils, Soil types, Oak trees, Chaparral, Rainfall, Precipitation (Atmospheric), Wet seasons, Dry seasons, Weather patterns, Moisture stress, Rainfall disposition.

Identifiers: *Mediterranean ecosystems, *Israel, *Vegetation types, Biotic history, Moisture regime.

Mediterranean vegetation types of Israel and California were compared from a dynamic and holistic viewpoint. When a comparison was made of climate, soils, vegetation, and biotic history of these two ecosystems, closest ecological equivalence occurred between valley oak grassland savanna of Israel and blue oak grassland savanna of California. Amount of rainfall, monthly distribution, and rainfall variability were compared between Auberry, California, and Nazareth, Israel. These two sites showed similar annual averages and variability of precipitation. In California, however, the rain season was longer, leading to greater unreliability in moisture regime and increased probability of moisture stress. These factors produce a more erratic and unfavorable plant climate. (Carr-Arizona)
W70-06810

INFLUENCE OF DROUGHT AND GRAZING ON MORTALITY OF FIVE WEST TEXAS GRASSES,

Texas Tech Univ., Lubbock. International Center for Arid and Semi-Arid Land Studies.

Thadis W. Box.
Ecology, Vol 48, No 4, p 654-656, Summer 1967. 3 tab, 15 ref.

Descriptors: *Drought, *Grazing, *Mortality, *Texas, *Forage grasses, Grama grasses, Switchgrass, Forages, Range grasses, Semiarid climates, Drought resistance, Drought tolerance, Plant physiology, Soil types.

Identifiers: *Grazing effects, *Sideoats grama, *Sand lovegrass, *Indiangrass, *Silver bluestem, Growth forms, Clones.

This study examined combined effects of drought and grazing on grasses growing in grazed and ungrazed pastures of Brownfield fine sand, eroded phase. The experiment took place in West Texas during a four-year drought (1962-1965). Percentage of dead clones was higher (P .01) among grazed plants than among ungrazed plants, even though grazing pressure was light. No ungrazed plants of silver bluestem, sideoats grama, switchgrass, or Indiangrass were completely dead and only 3% of the sand lovegrass died. The respective percentages for the grazed pasture were 13%, 10%, 54%, 37%, and 40%. Ungrazed plants exhibited normal or hollow growth forms, but grazed plants showed only a strip of live material along one edge. The amount of dead material in a clone when compared with clone size correlated negatively (P .01) for ungrazed plants and positively (P .01) for grazed sand lovegrass and sideoats grama. (Carr-Arizona)
W70-06811

WATER REQUIREMENTS IN STRAINS OF VINE-MESQUITE (PANICUM OBTUSUM H. B. K.),

New Mexico State Univ., University Park. Dept. of Agronomy.
Vincent K. Weng, and Ferdinand A. Quinones.
Crop Science, Vol 9, No 4, p 412-415, July-August 1969. 4 tab, 9 ref.

Descriptors: *Water requirements, *Water utilization, *Forage grasses, *Range grasses, *Semiarid climates, Arid lands, Moisture stress, Water conservation, Erosion, Crop production, Crop response, Plant growth, Growth stages, Consumptive use, Transpiration, Correlation analysis, Grasses, Greenhouses, Least squares method.
Identifiers: *Water-use efficiency, *Vine-mesquite.

Nine strains of vine-mesquite were grown in a greenhouse and their water requirements studied. The experiment was conducted over a period of 126 days, during which time 3 herbage clippings were made. Plant water requirements (the ratio of transpiration to herbage yield) were determined. Transpiration, dry herbage yield, and water requirement showed no statistical difference among strains for any growth period or for the experiment as a whole. However, the 9 strains showed significant differences in transpiration throughout the study. Despite a large, significant negative genetic correlation between herbage yield and water requirement, there were no significant differences among strains in these traits. This would indicate that high herbage yield is not a reliable guide in selection of low water-use strains of vine-mesquite. (Carr-Arizona)
W70-06812

SOME ENZYME AND PROTEIN CHANGES ASSOCIATED WITH WATER STRESS IN WHEAT LEAVES,

Oklahoma State Univ., Stillwater. Dept. of Botany.
Charles A. Stutte, and Glenn W. Todd.
Crop Science, Vol 9, No 4, p 510-512, July-August 1969. 3 fig, 14 ref.

Descriptors: *Enzymes, *Protein, *Moisture stress, *Wheat, *Leaves, Plants, Plant physiology, Crops, Organic compounds, Iron, Electrophoresis, Water loss, Wilting, Droughts, Moisture availability, Moisture content, Amino acids.
Identifiers: Peroxidase, Lactic dehydrogenase.

Wheat leaves were studied under varying degrees of moisture stress in order to determine enzyme changes in their soluble proteins. Using acrylamide gel electrophoresis, changes in enzyme patterns were compared with changes in total protein and iron-containing protein. Under conditions of severe wilting lactic dehydrogenase was found in fewer bands, while iron-containing proteins not only ap-

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peared in a greater number of bands, but also increased in total quantity. As water stress increased some peroxidase bands disappeared and new ones appeared. Total peroxidase activity per unit of protein increased as wilting progressed, but the amount of total soluble protein declined drastically. (Carr-Arizona)

W70-06813

WATER-USE EFFICIENCY AND ITS ASSOCIATION WITH SEVERAL CHARACTERISTICS OF BLUE PANICGRASS (*PANICUM ANTIDOTALE RETZ.*) CLONES,
Arizona Univ., Tucson. Dept. of Agronomy; and Agricultural Research Service, Tucson, Ariz. Crops Research Div.
A. K. Dobrenz, L. Neal Wright, M. A. Massengale, and W. R. Kneebone.
Crop Science, Vol 9, No 2, p 213-216, March-April 1969. 3 fig, 4 tab, 14 ref.

Descriptors: *Forage grasses, *Water utilization, *Efficiencies, *Plant morphology, *Plant physiology, Arid lands, Southwest U.S., Environmental effects, Drought tolerance, Soil moisture, Moisture stress, Grasses, Soil-water-plant relationships, Consumptive use, Leaves, Crop production, Crop response, Growth stages, Transpiration, Amino acids, Proteins.

Identifiers: *Water-use efficiency, *Blue panicgrass, *Clones, Vascular bundles, Leaf anatomy, Lysine, Histidine, Arginine, Glysine, Alanine, Seedlings.

An experiment was designed to investigate water-use efficiency of blue panicgrass in relation to its physiological and morphological characteristics. A controlled environment was used to simulate the arid climatic conditions of the U.S. Southwest. Clones previously determined as either seedling drought tolerant or seedling drought susceptible were tested under three levels of soil moisture stress. Water-use efficiency was significantly associated with fresh weight, dry weight, total protein, and the amino acids alanine, arginine, glycine, histidine, and lysine. There was also a non-significant association between water-use efficiency and seedling drought tolerance. The most efficient water users had more vascular bundles in the leaves than the least efficient water users. (Carr-Arizona)

W70-06814

STOMATE DENSITY AND ITS RELATIONSHIP TO WATER-USE EFFICIENCY OF BLUE PANICGRASS (*PANICUM ANTIDOTALE RETZ.*),

Arizona Univ., Tucson. Dept. of Agronomy; and Agricultural Research Service, Tucson, Ariz. Crops Research Div.

A. K. Dobrenz, L. Neal Wright, A. B. Humphrey, M. A. Massengale, and W. R. Kneebone.
Crop Science, Vol 9, No 3, p 354-357, May-June 1969. 2 fig, 5 tab, 11 ref.

Descriptors: *Forage grasses, *Water utilization, *Efficiencies, *Stomata, *Transpiration, Evapotranspiration, Plant morphology, Plant physiology, Arid lands, Southwest U.S., Drought tolerance, Grasses, Leaves, Consumptive use, Soil moisture, Crop response.

Identifiers: *Blue panicgrass, *Water-use efficiency, *Stomate density, Clones, Seedlings, Culms.

Six clones of blue panicgrass from three different sources of germ plasm were selected for use in a study of the relationship between stomate density and water-use efficiency. The clones represented a wide range of previously-determined seedling drought tolerance. Stomate density was calculated from silicone rubber impressions taken on abaxial and adaxial leaf surfaces. Impressions were taken from the base, middle, and tip of each leaf and leaves were chosen from the base, middle and top of each culm. Stomate density ranged from 78 to 165 per square mm. Leaves at the base and middle of the culm had significantly higher stomate density

than those adjacent to the inflorescence. Stomate density did not differ for the three positions on the leaf. There was a non-significant correlation between water-use efficiency and stomate density, with drought tolerant clones having fewer stomates per unit area. (Carr-Arizona)

W70-06815

CORN YIELDS, SOIL TEMPERATURE, AND WATER USE WITH FOUR TILLAGE METHODS IN THE WESTERN CORN BELT,
Agricultural Research Service, Brookings, S. Dak. Corn Belt Branch; and South Dakota Agricultural Experiment Station, Brookings.
Tamlan C. Olson, and LaVern S. Schoeberl.
Agronomy Journal, Vol 62, No 2, p 229-232, March-April 1970. 1 fig, 5 tab, 11 ref.

Descriptors: *Crop production, *Corn, *Water utilization, *Corn Belt, *Cultivation, Semiarid climates, South Dakota, Soil temperature, Plant growth, Rainfall, Erosion, Soil erosion, Runoff, Water loss, Water conservation, Soil water, Soil moisture, Planting management.

Identifiers: *Plowing, *Listning, *Till planting, *Wheeltrack planting.

Corn yield and growth characteristics were compared for 4 tillage systems during crop years 1965, 1966, 1967 and 1968. The 4 methods under study were conventional plowing, wheeltrack planting, till planting, and listning. Although the difference was not significant between the four systems, the three reduced-tillage methods tended to have higher average grain yields. Rainfall during the four test years was below normal, so that the runoff-conserving characteristics of the reduced-tillage systems had little influence on the amount of water available to growing corn. Nonetheless, the experimental results show that the reduced-tillage methods can be used in the Corn Belt without sacrificing grain yield. These systems are also more economical and better able to protect against soil erosion and runoff. (Carr-Arizona)

W70-06817

EFFICIENCY OF WATER USE AND SEEDLING DROUGHT TOLERANCE OF BOER LOVEGRASS, *ERAGROSIS CURVULA NEES.*
Arizona Univ., Tucson. Dept. of Agronomy; and Agricultural Research Service, Tucson, Ariz. Crops Research Div.

L. Neal Wright, and A. K. Dobrenz.

Crop Science, Vol 10, No 1, p 1-2, January-February 1970. 2 tab, 8 ref.

Descriptors: *Range grasses, *Water utilization, *Efficiencies, *Drought tolerance, *Arid lands, Arid climates, Semiarid climates, Grasses, Consumptive use, Natural use, Transpiration, Crop response, Plant physiology, Growth stages, Environment, Environmental effects.

Identifiers: *Boer lovegrass, *Seedlings.

An experiment was established to determine the water-use efficiency of boer lovegrass and compare it with seedling drought tolerance. Lovegrass selections chosen to represent extremes of drought tolerance were studied in greenhouse and growth chamber environments in Tucson, Arizona. It was found that seedlings had lower water-use efficiency than mature plants, but relative ranking of selections did not vary with stage of growth. The most drought tolerant seedlings were the least efficient water users. An $r = .80$ correlation coefficient indicated significant negative association between seedling water-use efficiency and seedling drought tolerance. This association was also valid for mature plant water-use efficiency and seedling drought tolerance. Water-use efficiency was measured as the number of units of water transpired per unit of dry matter produced. (Carr-Arizona)

W70-06819

LOWER ELEVATIONAL LIMITS OF MONOTONE TREES. II. ENVIRONMENT-KEYED RESPONSES OF THREE CONIFER SPECIES,
Redlands Univ., Calif. Dept. of Biology.
Robert D. Wright.

Botanical Gazette, Vol 129, No 3, p 219-226, September 1968. 3 fig, 3 tab, 13 ref.

Descriptors: *Pine trees, *Conifers, *Elevation, *Environmental effects, *Distribution patterns, Altitude, Mountains, Environment, Environmental gradient, Climate, Climatic zones, Heat resistance, Drought tolerance, Moisture stress, Soil moisture, Phenology, Growth rates, Root development, Root systems, Coniferous trees, California.

Identifiers: *Knobcone pine, *Coulter pine, *Sugar pine, *Elevation limits, Seedlings, Transpiration rates, San Bernardino Mountains.

Knobcone pine, Coulter pine, and sugar pine were studied in laboratory and field experiments. Growth tests were performed in an attempt to discover what mechanisms determined lower elevation limits of the species. In the area under study, sugar pine was found at the highest elevations, Coulter at middle elevations, and knobcone at lowest elevations. Sugar pine was quite different from knobcone and Coulter pines in many respects, such as seedling drought tolerance, seedling survival in the field, phenology of shoot and needle elongation, rooting pattern in the field, and sensitivity of diameter growth rate to low elevation. Sugar pine was found to be least drought tolerant of the species under study, followed by knobcone pine, and then by Coulter pine. The fact that the latter two species are in inverse order when compared with their elevation positions appears to indicate that past wildfires may have effected their present distribution. (Carr-Arizona)

W70-06820

ESTIMATION OF THE OSMOTIC POTENTIAL OF CITRUS SEEDLING LEAF SAP AT DIFFERENT SOIL-MOISTURE LEVELS BY MEANS OF REFRACTOMETRY AND CONDUCTIMETRY,

National and Univ. Inst. of Agriculture, Rehovoth (Israel). Volcani Inst. of Agriculture Research. H. Bielorai.

Annals of Botany, Vol 32, No 127, p 473-477, July 1968. 1 fig, 1 tab, 8 ref.

Descriptors: *Osmotic pressure, *Soil moisture, *Soil-water-plant relationships, *Refractivity, *Electrical conductance, Leaves, Plant physiology, Moisture content, Moisture deficit, Dehydration, Wilting, Turgidity, Environmental effects, Soil water, Root zone, Electrolytes, Conductivity, Citrus fruits, Oranges, Limes.

Identifiers: *Osmotic potential, *Seedlings, *Sap, *Refractometry-conductimetry method, Cryoscopy, Soluble metabolites, Soil matric potential.

Sour orange and sweet lime species were tested at various soil-moisture levels to determine the electrical conductivity and refractive index of their leaf saps. Osmotic potentials of soluble metabolites and electrolytes were estimated, respectively, from functions relating sucrose concentration and electrical conductivity to osmotic potential. The sum of these two estimates correlated significantly ($r=0.957$) with total osmotic potential of the leaf sap as determined by cryoscopy. Since the cryoscopic method is not accurate below the level of -6 bars, the new technique should be extremely useful for taking field measurements of changes in osmotic potential. (Carr-Arizona)

W70-06823

UTILIZATION AND MANAGEMENT OF WATER IN THE ARID ZONES OF MEXICO (IN SPANISH),
Instituto Tecnológico y de Estudios Superiores de Monterrey (Mexico). Departamento de Suelos e Irrigación.

Jaime Leal Diaz.

Water in Plants—Group 21

English summary. Symposium on Increasing Food Production in Arid Lands, Texas Tech College, Lubbock, International Center for Arid and Semi-Arid Land Studies, Publication No 3, p 273-292, 1969. 4 fig, 6 tab, 24 ref.

Descriptors: *Water utilization, *Water management (Applied), *Mexico, *Arid lands, *Sorghum, Grains (Crops), Crop production, Crop response, Drought, Irrigation, Dry farming, Irrigation systems, Water conservation, Soil moisture, Soil water, Evaporation, Evaporation control, Transpiration, Furrows, Gravels, Stubble mulching, Moisture availability, Agriculture, Water loss, Humidity, Distance, Soil-water-plant relationships.
Identifiers: Spacing.

Researchers studied several problems of conserving and utilizing water for agriculture in arid lands in Mexico. Among the information sought was: (1) effective methods of reducing soil water loss from evaporation; (2) influence of plants on conservation of soil water; (3) importance of furrow form and width in dry farming sorghum; (4) influence of soil moisture on sorghum production. Of the possible land covers that were studied, corn stubble and gravel were the most effective in minimizing soil water evaporation, with gravel allowing better plant development than stubble. Barren ground conserved soil moisture better than vegetative cover. Six furrow widths between 60 and 210 cm were tested to determine optimum distance between furrows. Best width was 1.42 m. The most important variables influencing optimum distance were soil moisture, soil fertility, and evapotranspirative demand of the sorghum. Increasing furrow width during drought periods was beneficial for sorghum development. In the experiment with 4 systems of irrigation, data showed that a constant relationship was maintained between amount of evaporative water loss and grain production. (Carr-Arizona)
 W70-06825

INFLUENCE OF SITE ON MESQUITE MORTALITY FROM 2,4,5-T,
 Texas Tech Univ., Lubbock. International Center for Arid and Semi-arid Land Studies.
 B. E. Dahl, Robert B. Wadley, Mel George, and Jim Talbot.
 International Center for Arid and Semi-arid Land Studies, Special Report Number 33: Noxious Brush and Weed Control Research Reports—1969, p 7-17, December 31, 1969. 1 fig, 5 tab, 15 ref.

Descriptors: *Environmental effects, *Sites, *Mesquite, *Mortality, *2-4-5-T, Range management, Brush control, Weed control, Chemcontrol, Brush, Chaparral, Desert plants, Arid lands, Herbicides, Application methods, Organic compounds, Phenology, Plant growth regulators, Plant growth substances, Growth stages, Plant physiology, Habitats, Soil environment, Soil temperature, Soil moisture, Soil water, Soil texture, Calcium carbonate, Semiarid climates.
Identifiers: *Honey mesquite.

A study of various mesquite-infested sites in Texas was instituted in order to try to isolate reasons why site differences influence herbicide effectiveness. Soil temperature was found to be the single most important factor influencing response of honey mesquite to applications of 2,4,5-T. Temperatures measured at a 6-in depth were not useful, but those from an 18-in depth were found to relate directly to 2,4,5-T effectiveness. Another extremely important variable was growth stage. A mesquite tree with any degree of flower development was harder to kill than plants in other stages of growth. Soil moisture was the third most important factor, but only when in combination with other variables. Data suggested that for maximum herbicide effectiveness soil should be wet at a depth of 7-12 in below the surface and dry below 36 in. Other factors studied included calcium carbonate in the soil, air temperature, relative humidity, time of day, and soil texture. (See also W70-06827). (Carr-Arizona)
 W70-06826

DIMETHYL SULFOXIDE AND CHEMICAL BUD STIMULATION TO INCREASE HERBICIDE ACTIVITY IN MESQUITE,
 Texas Tech Univ., Lubbock. International Center for Arid and Semi-Arid Land Studies.
 Melvin R. George, Jimmy Talbot, and B. E. Dahl.
 International Center for Arid and Semi-Arid Land Studies, Special Report No 33: Noxious Brush and Weed Control Research Reports - 1969, p 18-24, December 31 1969. 3 tab, 23 ref.

Descriptors: *Mesquite, *Weed control, *Herbicides, *2-4-5-T, *Carriers, Desert plants, Chaparral, Range management, Organic compounds, Solvents, Chemcontrol, Plant growth regulators, Translocation, Bark, Phloem, Adjuvants, Penetration, Semiarid climates.
Identifiers: *DMSO (Dimethyl sulfoxide), *Tordon 225, *IAA (Indole Acetic Acid), *Honey mesquite, *Chemical bud stimulation, Synergistic effects, Gibberellic acid, Kinetin.

DMSO (dimethyl sulphoxide) was tested as a carrier for 2,4,5-T and Tordon 225 in an attempt to improve penetration and translocation of herbicides. DMSO did not increase movement of the tested herbicides through basal mesquite bark, but 2,4,5-T in DMSO was effective when applied by the frill method. This would seem to indicate that a barrier in the bark prevents movement of 2,4,5-T in DMSO. Diesel fuel effectiveness was reduced when it was combined with DMSO as a carrier for 2,4,5-T. Effectiveness of foliar application of Tordon 225 was also reduced when the herbicides was carried in DMSO. When applied alone or in water mixture DMSO was non-toxic. The experiments also indicated that the hormones IAA, gibberellic acid, and kinetin, whether alone or in DMSO, did not effect the dormant buds on mesquite seedlings. In sum, DMSO appears to have little usefulness in chemical control of mesquite. (See also W70-06828). (Carr-Arizona)
 W70-06827

CORRELATION OF WEATHER VARIABLES TO MESQUITE DAMAGE BY FIRE,
 Texas Tech Univ., Lubbock. International Center for Arid and Semi-Arid Land Studies.
 Henry A. Wright, and Carlton M. Britton.
 International Center for Arid and Semi-Arid Land Studies, Special Report No 33: Noxious Brush and Weed Control Research Reports, p 25-34, December 31 1969. 4 fig, 1 tab, 14 ref.

Descriptors: *Mesquite, *Weed control, *Burning, *Mortality, *Grasslands, Desert plants, Chaparral, Range management, Cultural control, Texas, Size, Moisture content, Humidity, Air temperature, Winds, Wind velocity, Variability, Semiarid climates, Soil temperature.
Identifiers: *Tobosa, *Controlled burning, *Weather variables, *Fuel moisture, Fine fuels, Burndown, Ignition, Southern Mixed Prairie, Soil surface temperature.

Experiments were conducted on 24 tobosa stands infested with mesquite to determine effects of various weather conditions on mesquite ignition, burn-down, and mortality. Average maximum soil surface temperatures were recorded and varied from 470 F to 730 F. They did not appear to correlate significantly with any weather variable. Percentage of burndown ranged from 14.4% to 89.1%. Independent variables of air temperature, relative humidity, total fuel, and wind speed accounted for 89% of total variation in burndown. Percentage ignition varied from 33.6% to 94.9%. Using the same variables as those considered for burndown, 81% of total variation in ignition was accounted for. The best single predictor for ignition and for burndown was relative humidity, accounting for 55.8% and 46.7%, respectively, of total variation. Mortality percentages on plots ranged from 0 to 24%. Although tobosa fuel was the most important variable, no significant amount of variation in % of mortality was due to any single independent variable. Among variables tested were air temperature, fuel moisture, relative humidity, soil moisture, tobosa fuel, total fuel, wind speed, the square of the

preceding variables, and all possible interactions. Stem size was also found to influence tree mortality. Prediction equations for ignition and burndown are presented, but it must be remembered that data on which the equations are based were derived from plots on which mesquite had been previously sprayed by herbicides. (See also W70-06829). (Carr-Arizona)
 W70-06828

RESPONSE OF REDBERRY JUNIPER TO SEASON OF TOP REMOVAL,
 Texas Tech Univ., Lubbock. International Center for Arid and Semi-Arid Land Studies.
 Joseph L. Schuster, and James George.
 International Center for Arid and Semi-Arid Land Studies, Special Report No 33: Noxious Brush and Weed Control Reports - 1969, p 49-52, December 31, 1969. 3 fig, 1 tab, 3 ref.

Descriptors: *Juniper trees, *Period of growth, *Growth stages, *Vegetation regrowth, *Brush control, Weed control, Chaparral, Range management, Brush, Cultural control, Seasonal, Cutting management, Phenology, Plant growth, Size, Bark, Mortality, Rainfall, Precipitation (Atmospheric), Semiarid climates, Moisture content, Soil moisture, Texas, Soil-water-plant relationships, Plant physiology.
Identifiers: *Redberry juniper, *Top removal, Leader elongation.

An experiment on redberry juniper was undertaken in West Texas in order to determine the most effective date of top removal when attempting to prevent regrowth. Trees were randomly chosen and placed in five classes according to stem circumference. Two trees from each size class were cut near ground level on each of 19 cutting dates distributed throughout the year. Data from one year after cutting indicated that the optimum time for redberry juniper control using the top removal method was during the May-August summer period. It was also found that as tree size increased, amount of regrowth increased. Moisture content of resprouts showed no correlation to amount of regrowth. Although plant moisture content was affected by soil moisture and stage of growth, there appeared to be no relationship between percentage moisture in the plant at time of cutting and the amount of regrowth. (See also W70-06826). (Carr-Arizona)
 W70-06829

FOURWING SALTBUCK SURVIVAL AFTER INUNDATION,
 Forest Service (USDA), Albuquerque, N. Mex. Rocky Mountain Forest and Range Experiment Station.
 Earl F. Aldon.
 USDA, Forest Serv. Res. Note RM-165, 2 p, 1970, 1 fig.

Descriptors: *Plant growth, *Vegetation effects, *Shrubs, *Land management, Watershed management, Grasslands, Revegetation, Vegetation establishment, Range management, New Mexico.
Identifiers: *Ground cover, *Watershed restoration.

Four-week-old fourwing saltbush transplants are subjected to high mortality if planted in areas likely to be inundated for longer than 30 hours.
 W70-06846

AGE AND SPACE DISTRIBUTION OF THE DESERT SHRUB LARREA DIVARICATA,
 Duke Univ., Durham, N.C. Dept. of Botany.
 Michael G. Barbour.
 Ecology, Vol 50, No 4, p 679-685, Summer 1969. 2 fig, 3 tab, 21 ref.

Descriptors: *Age, *Desert plants, *Distribution patterns, *Ecological distribution, *Spatial distribution, Environment, Environmental effects, Population, Biological communities, Distribution,

Field 02—WATER CYCLE

Group 21—Water in Plants

Germination, Shrubs, Xerophytes, Plant growth, Saline soils, Salt tolerance, Alkaline soils, Hydrogen ion concentration, Rainfall, Precipitation (Atmospheric), Deserts, Arid lands, Southwest U.S., Soil types, Soil-water-plant relationships, Toxins, Soil contamination.

Identifiers: *Creosote bush, *Age distribution, *Ecotones, Sonoran Desert, Chihuahuan Desert, Mojave Desert.

Creosote bush (*Larrea divaricata* Cav.) was observed throughout its range in the United States in order to determine age and spatial distribution of shrubs in *Larrea* stands and degree of soil changes across abrupt ecotones. Different stands of shrubs exhibited clumped, regular, or random spatial distributions. It was possible that most of the Mojave-Sonoran sites rejected by the random-quadrat method would fall in the regular distribution category. Age distribution showed significant non-central tendencies for 90% of the stands on Mojave-Sonoran sites, but only on 43% of Chihuahuan sites. These departures from normal distribution indicate that germination and survival of *Larrea* are rare, especially in the more xeric Mojave-Sonoran area. Topsoil changes in pH and salinity usually did not correlate with *Larrea* boundaries, nor were the changes generally sufficient to affect germination and seedling growth. (Carr-Arizona)

W70-06830

STUDIES ON STRUCTURE IN PLANT COMMUNITIES; VI: THE SIGNIFICANCE OF PATTERN EVALUATION IN SOME AUSTRALIAN DRY-LAND VEGETATION TYPES,

Australian National Univ., Canberra. Research School of Biological Sciences; and Sydney Univ., (Australia). School of Biological Sciences.

D. J. Anderson, S. W. L. Jacobs, and A. R. Malik. Australian Journal of Botany, Vol 17, No 2, p 315-322, August 1969. 4 fig, 1 tab, 24 ref.

Descriptors: *Structure, *Biological communities, *Desert plants, *Distribution patterns, *Density, Ecology, Ecological distribution, Spatial distribution, Distribution, Environment, Environmental effects, Plant populations, Grasses, Population, Soil moisture, Arid lands, Semiarid climates, Deserts, Rainfall, Drought, Vegetation, Limiting factors, Phenology, Succession, Statistical methods.

Identifiers: *Australia, *Vegetation types, *Patterns, Poissonian model, Saltbush.

Density data from a variety of Australian dry-land vegetation types provides evidence that randomness may be as frequent as patterned distributions. Strict regularity of density distribution could not be detected in the study areas, at least not with the Poissonian model that was employed. Therefore, in contrast with those persons who assume that regular distributions can be logically expected in most vegetation types, the authors feel such an assumption is logical only if (1) the factors imposing regularity are uniformly distributed, (2) the controlled plants are phenotypically uniform. The *Atriplex* sites that were studied are an example of an area in which the first assumption does not hold; patterns were found in microtopography, soil moisture, and associated nutrients. Neither does the second assumption hold for the *Atriplex vesicaria* material that was investigated. Nevertheless, there were areas under study, such as the mixed ephemeral grassland of the Simpson Desert, in which randomness probably was due to colonizing activity. The growth of that transient community following the drought-breaking rains of 1966 would conform to the traditional theories of random structure in colonizing and relict populations. (Carr-Arizona)

W70-07049

STUDIES IN THE ECOLOGY OF THE RIVERINE PLAIN; IV: BASAL AREA AND DENSITY CHANGES OF DANTHONIA

CAESPITOSA GAUDICH. IN A NATURAL PASTURE GRAZED BY SHEEP,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Plant Industry.

O. B. Williams.

Australian Journal of Botany, Vol 16, No 3, p 565-578, December 1968. 4 fig, 2 tab, 32 ref.

Descriptors: *Density, *Grazing, *Sheep, *Pastures, *Grasses, Forage, Pasture management, Range management, Grasslands, Deterioration, Ruminants, Ecology, Ecological distribution, Environment, Environmental effects, Plant growth, Growth stages, Mature growth stage, Semiarid climates, Rainfall, Precipitation (Atmospheric), Drought, Age, Distribution patterns, Plant populations, Arid lands.

Identifiers: *Australia, *Danthonia, Age distribution, Botanical composition, Gilgai, Seedlings.

Grazing treatment has demonstrated amazingly little effect on botanical composition of pasture vegetation in sheep grazing experiments in arid and semiarid regions of eastern Australia. In a further study of grazing treatments, changes in density and basal area of *Danthonia* were measured over a 9 year period under varying grazing pressures. The grassland under study was an old man saltbush shrub steppe degraded to a short grassland through the combined actions of intermittent drought and grazing by cattle, sheep, rabbits, and red kangaroo. At the end of the experimental period basal area showed no significant differences (at the 5% level) between treatments. Contribution by various age groups to basal area and plant density of *Danthonia* also showed no significant differences (5% level) between treatments. When first measured, 5 of the 8 seedling populations were denser in grazed areas than in ungrazed areas and this relationship held for all but one of the ensuing years. The reason for the tremendous decline in basal area in 1951 appears to have been due to the relatively dry summer and fall of 1950-51. High levels of rainfall in 1949 and 1950 probably led to growth that could not be sustained in a dry year. (Carr-Arizona)

W70-07050

SOIL MOISTURE IN RELATION TO VEGETATION DISTRIBUTION IN THE MOUNTAINS OF NORTHERN IDAHO,

Washington State Univ., Pullman.

For primary bibliographic entry see Field 02G.
W70-07051

INFLUENCE OF SUBSURFACE IRRIGATION ON COTTON YIELDS AND WATER USE,

New Mexico State Univ., University Park. Dept. of Agricultural Engineering; and New Mexico State Univ., University Park. Dept. of Agronomy. Eldon G. Hanson, and B. C. Williams.

American Society of Agricultural Engineers, 1968 Winter Meeting, Chicago, Illinois, December 10-13 1968, Paper presented. 11 p, 4 fig, 2 tab, 10 ref. OWRR Project No A-006 N. Mex.

Descriptors: *Cotton, *Crop production, *Subsurface irrigation, *Irrigation systems, *Irrigation efficiency, Irrigation effects, Irrigation, Surface irrigation, Irrigation design, Water utilization, Water conservation, Consumptive use, Rates of application, Soil water movement, Capillary action, Flow, Plastic pipes.

Identifiers: Suspended particles.

Effect of subsurface irrigation on cotton yield was studied for 3 growing seasons. Cotton plants grown with subsurface irrigation had significantly higher yields than plants grown with surface irrigation. Furthermore, potential water savings obtained by using subsurface irrigation appeared to be in excess of 30%. Perforated half-inch plastic pipe placed 10 to 12 inches deep under each row was the basis of the subsurface system. There was difficulty in obtaining a complete stand of cotton with subsurface irrigation due to the slow rate of capillary flow from the pipe. Flow from pipe to soil was partially ob-

structed by suspended particles in the water. Pressure had to be increased in order to apply design rates of flow through the system. Rate of water application with the subsurface system ranged from 0.10 to 0.30 inches per day. (Carr-Arizona)

W70-07056

STOMATAL NUMBER AND SIZE AS RELATED TO SOIL MOISTURE IN TREE XEROPHYTE IN ISRAEL,

National and Univ. Inst. of Agriculture, Rehovoth (Israel). Volcani Inst. of Agricultural Research.

I. Gindel.

Ecology, Vol 50, No 2, p 263-267, Early Spring 1969. 1 fig, 2 tab, 17 ref.

Descriptors: *Stomata, *Soil moisture, *Xerophytes, *Trees, *Plant morphology, Transpiration, Moisture tension, Moisture availability, Epidermis, Leaves, Density, Size, Arid lands, Arid climates, Ecology, Environment, Environmental effects, Irrigation effects, Acclimatization, Climatic zones, Drought, Semiarid climates.

Identifiers: *Israel, *Stomatal density, *Semidesert, *Indigenous species, Introduced species.

Number and size of stomates were measured for 32 tree species and mean leaf area was calculated for 14 of them. Eight of the species were native to Israel and 24 were introduced species, mostly from Australia. Half of the trees of each species were irrigated and half were not. Mean leaf area was larger for 5 irrigated and 8 nonirrigated species, but difference in leaf area was not significant for 11 of them. Stomatal density was significantly higher (at the 1% level) in nonirrigated than in irrigated trees. Stomata appeared on both the upper and lower leaf epidermis in the majority of successfully acclimated species and some indigenous ones. Especially when compared with trees having stomata only on the lower epidermis, species with stomata on both sides of the blade were noted for their xerophytic properties. Such trees often grew without irrigation in the Israeli semidesert and survived drought periods. (Carr-Arizona)

W70-07057

2J. Erosion and Sedimentation

BANK STABILIZATION IN SUSQUEHANNA RIVER BASIN,

Corps of Engineers, Baltimore, Md. Basin Planning Branch.

For primary bibliographic entry see Field 04D.

W70-06733

DISTRIBUTION OF MAJOR, MINOR, AND TRACE CONSTITUENTS IN UNCONSOLIDATED SEDIMENTS FROM SOUTHERN LAKE MICHIGAN,

Illinois State Geological Survey, Urbana.

Neil F. Shimp, Harry V. Leland, and W. Arthur White.

Illinois Geological Survey Environmental Geology Note No 32, March 1970. 19 p, 4 fig, 3 tab, 9 ref. append.

Descriptors: *Bottom sediments, *Lake Michigan, *Chemical analysis, Trace elements, Ions, Clays, Clay minerals, Organic matter, Lakes, Limnology, Sedimentation, Water analysis, Sampling, Data collections, Water pollution effects, Environmental effects.

Identifiers: Lake Michigan sediments, Environmental geology.

Preliminary results from a study of the chemical composition of southern Lake Michigan sediments indicate that lead, bromine, zinc, nickel, and chromium accumulate in the upper few centimeters of these lake deposits. Concentrations of these elements appear to be related to the amount of organic carbon in the sediments. In deeper sediments, most trace element concentrations increase as the

Erosion and Sedimentation—Group 2J

amount of less than 2-micron clay increases. The samples were subjected to X-ray fluorescence, neutron activation, optical emission, atomic absorption, and wet chemical methods. Major constituents determined were Al, Si, Fe, Ca, Mg, K, Na, inorganic carbon, and organic carbon. Ti, Mn, P, and S were found in smaller amounts. Trace elements determined were B, Be, Br, Cd, Cr, Cu, La, Ni, Pb, Sc, V, and Zn. Amounts of less than 2-micron clay, clay mineral composition, acidity, and oxidation-reduction potential also were determined. (Knapp-USGS)
W70-06778

ERODED SOILS OF THE LOWER SWANSEA VALLEY,

University Coll. of Swansea (Wales). Dept. of Geography.
E. M. Bridges.
Journal of Soil Science, Vol 20, No 2, p 236-245, September 1969. 10 p, 1 fig, 2 plate, 3 tab, 13 ref.

Descriptors: *Soil erosion, *Vegetation effects, *Sediment yield, Geomorphology, Topography, Gully erosion, Sheet erosion, Runoff, Soil stability, Air pollution effects.

Identifiers: *Swansea (Wales), Unvegetated soil.

The investigation attempts to ascertain rates and amounts of soil erosion from a small unvegetated area (120 m X 15 m). Measurements from markers embedded in the soil indicate a removal of 10 mm per annum on 5 deg slopes, 32 mm per annum on 45 deg slopes, and 43 mm per annum on 62 deg slopes. A sediment trap indicated that in a week when there was 56.8 mm rain, approximately 60 g/sq m was eroded. Results of the work are used in an explanation of the eroded soils of a much larger area, known as the Lower Swansea Valley. (Knapp-USGS)
W70-06772

BIOTIC REGULATION OF PARTICULATE AND SOLUTION LOSSES FROM A FOREST ECOSYSTEM,

Yale Univ., New Haven, Conn. School of Forestry; and Dartmouth Coll., Hanover, N.H. Dept. of Biological Science.

F. H. Bormann, G. E. Likens, and J. S. Eaton.
Bio Science, Vol 19, No 7, p 600-610, 1969. 11 p, 9 fig, 8 tab, 30 ref. NSF Grants GB1144, GB4169, GB6742, and GB6757.

Descriptors: *Erosion, *Leaching, *Small watershed, *New Hampshire, Ecology, Vegetation effects, Nutrients, Cycling nutrients, Sediment transport, Provenance, Water pollution sources, Hydrologic cycle.

Identifiers: Experimental watersheds.

Major losses of nutrients from terrestrial ecosystems result from two processes: Particulate matter removal accomplished by erosion and transportation in surface drainage water, and solution removal accomplished by dissolution and transportation of solutes by surface and subsurface drainage water. Particulate matter losses from the Hubbard Brook (NH) watershed-ecosystems show seasonal variations, with the bulk of the material being exported during the spring runoff period. However, a single autumnal storm of unusual intensity accounted for 54% of the total particulate matter output during a 2-year period. Total particulate matter losses amounted to 2.5 metric tons/sq km/year. This value is appreciably less than values reported for other similar regions. Total output of dissolved substances was 14 metric tons/sq/km/yr. This is about 25% of the dissolved load predicted for such areas by Langbein and Dawdy (Leopold et al., 1964). The relatively small losses of dissolved substances and particulate matter indicate that the Hubbard Brook ecosystem is very stable. This conclusion is also supported by the biotic structure of the ecosystem. Secondary ecological successions following severe disturbance of forest ecosystems result in significant 'conservation' of nutrients lost from the ecosystem. This effect is achieved by a

complex interaction of biomass accumulation, alteration of the hydrologic cycle, reduction of erodibility of the system, and changes in concentration of dissolved substances in drainage waters. (Knapp-USGS)
W70-06778

SOME CHEMICAL CHARACTERISTICS OF AEOLEAN DEPOSITS OF SNOW-SOIL ON PRAIRIE WETLANDS,

Fish and Wildlife Service, Jamestown, N. Dak.
V. A. Adomaitis, H. A. Kanrud, and J. A. Shoesmith.

North Dakota Academy of Science, Vol 21, p 65-69, 1967. 5 p, 4 tab, 3 ref.

Descriptors: *Sedimentation, *Wetlands, *Snow, *Dusts, *Aeolian soils, Dust storms, Blizzards, Silts, Winds, Prairie soils, Soil chemistry, Nutrients, Trace elements.

Identifiers: Prairie potholes.

Broad ecological studies were made to describe the prairie wetlands of North Dakota. A close natural relationship exists between wetland ecology and geochemistry. The type of matter transported during winter storms in the prairie region, and its effect on marshes or other areas where snow is trapped was studied. The aeolian mixture of snow and soil from surrounding fields without vegetation yielded nearly twice as much deposit into the prairie potholes as snow from fields with vegetation. Total alkalinity was 1.7 times as high, total hardness was 1.8, calcium hardness 1.6, magnesium hardness 3.0, and phosphates 1.6, sulfates 1.2 and silica 1.9 times as high. The comparison of nitrate nitrogen levels for clean and dirty snow shows dirty snow to be 2.8 times as high. These ratios imply that fair amounts of top soil travel with the snow during high winter winds. Prevention of wind erosion in winter on the northern prairie also extends the topographical life of waterfowl breeding habitats. (Knapp-USGS)
W70-06801

PRELIMINARY STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS FROM THE SOUTHWESTERN PART OF LAKE MICHIGAN,

Illinois State Geological Survey, Urbana; and Illinois Univ., Urbana.

J. A. Lineback, W. A. White, N. J. Ayer, Charles Collinson, and H. V. Leland.
Illinois State Geological Survey, Environmental Geology Notes No 30, Feb 1970. 20 p, 6 fig, 2 plates, 11 ref.

Descriptors: *Sediments, *Lake Michigan, Stratigraphy, Sampling, Cores, Clay minerals, Pollutant identification.

Identifiers: Shipek grab sampler, Radiocarbon dating, Clay mineralogy, Unconsolidated sediments, Sedimentary pollution.

Lacustrine sediments were sampled at 4-mile intervals along a line extending from 12 to 32 miles due east from Waukegan, Illinois. The sediment sequence includes a thin floor of sandy silty clay, dark gray and brownish silty clays with black clay interlayers, orange-brown clay, and, finally, pink clay overlying glacial outwash and till. Radiocarbon dating of black interlayers indicated their age at approximately 6920 years. Grain size decreases with depth. Water content of core samples ranges from 100 to more than 200% of dry weight. The cores include illite, chlorite, kaolinite, and expandable clay minerals. The content of the latter decreases with the depth of the sediment in agreement with their degradation to kaolinite. (Wilde-Wisconsin)
W70-06974

CHAPTER IV: SEDIMENT SOURCES AND SEDIMENT YIELDS, PROPOSED MANUAL ON

SEDIMENTATION ENGINEERING.

ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY6, Paper 7337, p 1283-1329, June 1970. 47 p, 26 fig, 10 tab, 93 ref.

Descriptors: *Sediment yield, *Provenance, Sediment load, Stream erosion, Erosion, Highways, Channel erosion, Gully erosion, Sheet erosion, Soil erosion, Urbanization, Strip mines.

Identifiers: Sediment sources.

Methods and procedures are analyzed for determining erosion rates from water-borne sediments, along with sediment yield or deposition rates at locations downstream from the erosion source. Emphasis is placed on the erosion types and processes which cause the most engineering problems, either by virtue of the large sediment quantities involved or by the locally severe damages incurred. Accelerated erosion and deposition rates from man's activities are of special concern; these derive from sheet erosion processes on tilled lands and from such specialized activities as strip mining, urban development, construction of highways and utilities, and sheet erosion on any portion of the land surface that is denuded or inadequately protected. Erosion and deposition rates caused by channelization or runoff waters in upland gullies and downstream drainageways are also considered. Present bases for estimating these rates, on both a storm and an average annual basis, are given. (Knapp-USGS)
W70-06979

EFFECT OF CONCENTRATION GRADIENTS ON THE PERFORMANCE OF A NUCLEAR SEDIMENT CONCENTRATION GAGE,

Agricultural Research Service, Oxford, Miss. Sedimentation Lab.

For primary bibliographic entry see Field 07B.

W70-07001

RIVERBED DEGRADATION PREDICTION,

Mississippi State Univ., State College.

Zelton L. Hales, Adnan Shindala, and Keith H. Denon.

Water Resources Research, Vol 6, No 2, p 549-556, April 1970. 8 p, 7 fig, 15 ref.

Descriptors: *Scour, *Degradation (Stream), *Stream erosion, *Reservoir operation, Erosion, Bank erosion, Discharge (Water), Dams, Weirs, Sediment load, Particle size, Alluvial channels, Equations.

Identifiers: Riverbed degradation.

A mathematical-graphical procedure for predicting the longitudinal extent of degradation with time downstream from large capacity reservoirs is presented. For such a prediction it is necessary to have an indication of the outflow release rates of the structure, original distribution curves of the bed materials, and channel cross sections. The evaluation of bed slope and the energy slope appears to be a critical factor in the computations. (Knapp-USGS)
W70-07002

STATISTICAL MODEL OF TURBULENCE IN SEDIMENT-LADEN STREAMS,

Kansas State Univ., Manhattan; and Geological Survey, Washington, D.C.

W. J. Conover, and N. C. Matalas.
ASCE Proceedings, Journal of the Engineering Mechanics Division, Vol 95, No EM5, Paper 6814, p 1063-1081, October 1969. 19 p, 1 tab, 9 ref, append.

Descriptors: *Turbulent flow, *Sediment transport, *Probability, *Statistical models, Stochastic processes, Mathematical models, Hydraulics, Sedimentation.

Identifiers: Random walk models.

Field 02—WATER CYCLE

Group 2J—Erosion and Sedimentation

Turbulent flow in a sediment-laden stream is described by a random walk model which simulates the behavior of sediment particles, fluctuating in depth near the surface of the stream down to the strembed. The basic aspect of this model is the probability laws which govern the transfer of mass for both water and sediment from one level to another throughout the total depth. The downstream velocity at each level is introduced to convert mass to momentum. Three sources of momentum loss are taken into account. The downstream velocities at the various levels, which are unknown, are determined from a set of equations based on the assumption that the expected momentum at a given level equals the sum of the expected momentum contributed from all levels and by gravity. The solution of these equations in the limit where the distance between levels goes to zero leads to the vertical velocity distribution of the sediment-water mixture which is dependent upon four parameters. (Knapp-USGS) W70-07022

STOCHASTIC HYDRODYNAMICS OF SEDIMENT TRANSPORT,
Pittsburgh Univ., Pa. Dept. of Civil Engineering.
Chao-Lin Chiu, and Kuang-Chian Chen.
ASCE Proceedings, Journal of the Engineering Mechanics Division, Vol 95, No EMS, Paper 6858, p 1215-1230, October 1969. 16 p, 22 fig, 4 ref, append.

Descriptors: *Sediment transport, *Mathematical models, *Statistical models, *Stochastic processes, Hydrodynamics, Hydraulics, Model studies, Bed load, Suspended load, Turbulent flow, Monte Carlo method.

Identifiers: Random walk processes.

A stochastic model has been used in a study of sediment transport by the Monte Carlo simulation method. Results include the three-dimensional unsteady sediment distribution that cannot be obtained by conventional techniques, as well as the steady uniform sediment distribution. The diffusion coefficient of sediment is also studied by the simulation method used. Such a method should find its application in a study of the initial, transient, or unsteady mixing pattern of solid wastes released from a point source in a flow field. (Knapp-USGS) W70-07023

RESEARCH NEEDS REGARDING SEDIMENT AND URBANIZATION,
Geological Survey, Fort Collins, Colo. Water Resources Div.
Harold P. Guy.

Journal of the Hydraulics Division, ASCE Proceedings, Vol 93, No HY6, p 247-254, November 1967. 16 ref. Paper 5596.

Descriptors: *Sediment yield, *Urbanization, *Erosion, Sediment transport, Bed load, Suspended load, Research and development, Water pollution sources, Silts.
Identifiers: Urban hydrology.

Sediment derived from construction in areas of urban growth has profound impact on downstream channels and water resources. Such sediment pollution is usually much more dynamic and intense than sediment derived from rural areas. Research needs concerning urban-derived sediment are similar to those already underway in rural areas; however, new emphasis must be given to exposed subsoils, to problems in existing stream channels, to pollution of existing and future water resources, and to more effective planning and phasing of construction. Some of the needed soils and stream channel research can be accomplished in laboratories, but much needs to be done on small areas at the construction sites. Although many urban research methods can be adapted from related rural programs, consideration must be given to the fact that the extent and location of the exposed subsoils in the drainage basin will change rapidly and that extremely high and variable sediment

loads will be imposed upon the stream channels. Better planning and legal backing will make research findings more useful. (Knapp-USGS) W70-07093

2K. Chemical Processes

SCAVENGING STUDY OF SNOW AND ICE CRYSTALS,

Illinois Inst. of Tech., Chicago.

For primary bibliographic entry see Field 02B.

W70-06744

GOLD CONTENT OF WATER, PLANTS, AND ANIMALS,

Geological Survey, Washington, D.C.

Robert S. Jones.

Report free on application to U S Geological Survey, Wash, D.C. 20242. Geological Survey Circular 625, 1970. 15 p, 3 tab, 75 ref.

Descriptors: *Water chemistry, *Trace elements, *Gold, *Sea water, *Fresh water, Plants, Animals, Surveys, Water analysis, Analytical techniques, Neutron activation analysis, Geochemistry, Solutes, Exploration.

Identifiers: Geochemical prospecting.

Sea water contains from 0.001 to 44 ppb (parts per billion) gold. The amounts of gold in fresh surface waters and groundwaters are also within this range. The average amount of gold in sea water as calculated from neutron activation analyses is 0.05 ppb. The maximum amount of gold detected in plant ash by neutron activation methods is 36 ppm (parts per million) and the average is about 7 ppm. This average, if correct, greatly exceeds the average concentration of gold in the earth's crust. The gold content of dry matter in animals as determined by neutron activation methods ranges from 0.0012 to 430 ppb. On the basis of scanty analyses, terrestrial plants and animals appear to contain more gold than marine plants and animals. (Knapp-USGS) W70-06761

A STEADY-STATE METHOD FOR DETERMINING DIFFUSION COEFFICIENTS IN SOIL,

Oxford Univ. (England). Soil Science Lab.

For primary bibliographic entry see Field 02G.

W70-06769

TRACE-ELEMENT CONTAMINATION OF PARKLANDS IN URBAN AREAS,

Edinburgh Univ. (Scotland). School of Agriculture.

For primary bibliographic entry see Field 05A.

W70-06770

EFFECTS OF ADSORBED CATIONS ON PHYSICAL PROPERTIES OF TROPICAL RED EARTHS AND TROPICAL BLACK EARTHS: I. PLASTIC LIMIT, PERCENTAGE STABLE AGGREGATES, AND HYDRAULIC CONDUCTIVITY,

Hawaii Agricultural Experiment Station, Honolulu. For primary bibliographic entry see Field 02G. W70-06771

QUANTITY AND QUALITY OF LOW FLOW IN THE HONDO CREEK BASIN, TEXAS, MARCH 27-28, 1968,

Geological Survey, San Antonio, Tex.

For primary bibliographic entry see Field 02E.

W70-06774

RATE OF CHEMICAL WEATHERING OF SILICATE MINERALS IN NEW HAMPSHIRE,

Dartmouth Coll., Hanover, N. H.; Yale Univ., New Haven, Conn.; and Forest Service (USDA), Durham, N. H. Northeastern Forest Experiment Station.

Noye M. Johnson, Gene E. Likens, F. H. Bormann, and Robert S. Pierce.

Geochimica et Cosmochimica Acta, Vol 32, p 531-545, 1968. 15 p, 1 fig, 7 tab, 20 ref. NSF Grants GB 1144 and GB 4169.

Descriptors: *Leaching, *Silicates, *Weathering, *Water chemistry, *New Hampshire, Calcium, Sodium, Magnesium, Potassium, Small watersheds, Clay minerals, Mineralogy, Soil chemistry, Soil water.

Identifiers: Soil weathering, Weathering rates.

The losses of dissolved Ca, Na, Mg and K were determined for six small watersheds in New Hampshire during the period 1963-1967. From the rate at which Ca and Na are lost, the steady-state chemical weathering rate is calculated at 800 kg of bedrock-till per hectare per year. Under podzol weathering conditions, a major part of the K and Mg released by the breakdown of primary minerals is apparently retained in pedogenic clays. (Knapp-USGS) W70-06795

GENESIS OF SOME GROUNDWATERS FROM IGNEOUS ROCKS,

Northwestern Univ., Evanston, Ill. Dept. of Geological Sciences.

Robert M. Garrels.

In: *Researches in Geochemistry, Volume 2: New York, John Wiley and Sons, Inc, p 405-420, 1967. 16p, 8 fig, 15 ref. NSF Grant (GP-4140).*

Descriptors: *Water chemistry, *Leaching, *Igneous rocks, *Groundwater, *Carbon dioxide, Mineralogy, Solubility, Silica, Calcium, Magnesium, Bicarbonates, Equilibrium, Geochemistry, Aqueous solutions.

Identifiers: Groundwater chemistry.

Interpretations that can be made from chemical analyses of actual waters are discussed. Groundwaters from feldspathic igneous rocks are a related group of waters used for illustration. Dilute groundwaters in igneous rocks, as sampled, seem to correspond in composition with the probable results of putting rock samples into water rich in carbon dioxide, closing the system, and then taking solution samples for analyses after various time intervals, assuming that the system is well behaved and that the various solid phases appear promptly after saturation. It should be possible to consider a given natural water analysis as representing a particular stage in an evolutionary sequence—a stage determined by the carbon dioxide content of the original water, the reactivity and surface area of the primary rock minerals, and the residence time of the water. (Knapp-USGS) W70-06799

Eh AND pH OF OILFIELD WATERS,

Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center.

A. Gene, Collins.

Producers Monthly, Vol 28, No 9, p 11-12, September 1964. 2 p, 1 fig, 18 ref.

Descriptors: *Water analysis, *Hydrogen ion concentration, *Oxidation-reduction potential, Water chemistry, Analytical techniques, Instrumentation, On-site tests.

Identifiers: Oilfield waters.

Accurate measurements of the Eh (oxidation-reduction potential) and pH (hydrogen ion concentration) of oilfield waters are needed to interpret their complex physicochemical systems. An apparatus was designed to aid in determining the Eh and pH of an oilfield water at the wellhead. A method for determining the Eh and pH of an oilfield water is described and possible applications of the resultant data are discussed. (Knapp-USGS) W70-06804

RAPID DETERMINATION OF CADMIUM AND COPPER IN PLATING WASTES AND RIVER WATER BY ATOMIC ABSORPTION SPECTROSCOPY,
Missouri Univ., Kansas City. Dept. of Chemistry.
For primary bibliographic entry see Field 05A.
W70-06806

CHEMICAL CHARACTERISTICS OF LAKE ONTARIO,
Bureau of Commercial Fisheries, Ann Arbor,
Mich. Biological Lab.
Herbert E. Allen.
Great Lakes Fishery Commission Technical Report
No 14, p 1-18, 1969. 1 fig, 5 tab, 14 ref.

Descriptors: *Sampling, *Lake Ontario, *Chemical properties, Dissolved oxygen, Hydrogen ion concentration, Alkalinity, Conductivity, Potassium, Sodium, Calcium, Silica, Nansen bottles.

Identifiers: Open water, Chemical variations.

Samples of open water were collected at 106 stations in Lake Ontario with the intention of establishing east-west and surface-subsurface variations in water quality. Determinations of pH values, alkalinity, specific conductance, and dissolved oxygen were performed on the research boat using samples collected with Nansen bottles. Determination of calcium, potassium, sodium, and silica was made in the laboratory. With the exception of dissolved oxygen, Lake Ontario was found to be chemically similar to Lake Erie, which supplies Lake Ontario with 85% of its water. The average concentration of dissolved oxygen in surface water was astonishingly high, varying from 8.85 to 9.76 ppm. (Wilde-Wisconsin)
W70-06966

HYDROCARBON DISTRIBUTION OF ALGAE AND BACTERIA, AND MICROBIOLOGICAL ACTIVITY IN SEDIMENTS,
California Univ., Berkeley. Dept. of Chemistry.
Jerry Han, and Melvin Calvin.
Proceedings of the National Academy of Sciences, Vol 64, No 4, p 436-443, 1969. 3 fig, 4 tab, 21 ref.

Descriptors: *Algae, *Microorganisms, *Bacteria, *Cytological studies, Biochemistry, Lipids, Chemistry, Diagenesis, Sediments, Lakes, Photosynthetic bacteria, Precambrian eras, Rocks. Identifiers: *Hydrocarbon, Prokaryotic cells, Eukaryotic cells, Morphological taxonomy, Nonphotosynthetic bacteria, Microfossils, Blue-green algae.

The evolutionary step from the prokaryotic cells of bacteria and blue-green algae to the eukaryotic cells of green algae, higher plants, and animals is marked by the appearance in the latter of specific hydrocarbons, particularly lipids. Determination of various hydrocarbon constituents of blue-green algae, nonphotosynthesizing bacteria, green algae, and photosynthesizing bacteria has indicated that chemistry may have more to contribute than any morphological analysis to the taxonomic classification of living organisms. On the other hand, the studies suggest the diagenesis and certain biological transformations of some hydrocarbons in sediments. (Wilde-Wisconsin)
W70-06969

THE CHEMICAL QUALITY OF IOWA'S WATER RESOURCES,
Geological Survey, Iowa City. Iowa Water Resources Div.

R. W. Coble.
In: Water Resources of Iowa, Symposium Proceedings, Iowa Academy of Science at Univ of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, p 51-67, Jan 1970. 17 p, 6 fig, 2 tab, 2 ref.

Descriptors: *Water quality, *Surface waters, *Groundwater, *Iowa, Aquifers, Solutes, Streamflow, Runoff, Nitrates, Saline water, Geochemistry, Hydrogeology, Hardness (Water).

Identifiers: Water quality maps.

Water of good quality is available from one or more sources throughout most of Iowa. Hardness and iron are nuisances in many places, but can be treated. Nitrate problems exist in some shallow groundwater supplies and in some streams at times of high runoff. Fluoride concentrations in excess of recommended concentrations are known to occur only in part of two aquifers. Iowa's streams usually contain water with less than 500 mg/l of dissolved solids. When the dissolved-solids content exceeds this amount, it is most generally the result of a higher bicarbonate content which occurs during times of low discharge in the winter months. Alluvial aquifers occupying the valleys of the major streams generally yield water of good quality. A large part of Iowa is underlain by one or more bedrock aquifers that contain good or fair quality water; although poor quality water does occur in all aquifers. The better waters from the bedrock aquifers generally are found in the northeastern one-half of Iowa and in smaller areas in the western and northwestern parts of the state. (See also W70-06981). (Knapp-USGS)
W70-06985

DIFFUSION COEFFICIENT OF SODIUM NITRATE IN AQUEOUS SOLUTION AT 25 DEG C AS A FUNCTION OF CONCENTRATION FROM 0.1 TO 1.0M,
Virginia Polytechnic Inst., Blacksburg. Dept. of Chemical Engineering.
H. S. Yeh, and G. B. Wills.
Journal of Chemical and Engineering Data, Vol 15, No 1, p 187-189, January 1970. 3 p, 2 fig, 3 tab, 8 ref. OWRR Project No A-002-VA.
W70-07094

Descriptors: *Diffusion, *Mass transfer, Electrolytes, Laboratory tests, Membrane processes, Mixing, Osmosis.

Identifiers: Diffusion coefficient.

The integral diffusion coefficient of sodium nitrate in aqueous system was determined by the diaphragm cell method in the concentration range from 0.1 to 1.0M at 25 deg C. A stepwise regression method was employed to convert the integral data to differential diffusion coefficient data. (Knapp-USGS)
W70-06994

A SYSTEM FOR THE ANALYSIS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN NATURAL WATERS,
Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics.

W. Gary Williams.
Report available from Clearinghouse Springfield, Va. as AD-673 426, for \$3.00 or \$0.65 in microfiche. M.S. Science Thesis, Massachusetts Institute of Technology Duplicated Report, June 1968. 60 p, 14 fig, 4 tab, 20 ref. ONR Contract No 1841 (74).

Descriptors: *Water analysis, *Dissolved oxygen, *Nitrogen, *Argon, *Sea water, Instrumentation, Chromatography, Gases, Calibrations, Chemical analysis, Electrolysis.

Identifiers: Dissolved gas analysis.

A complete system was developed for the shipboard analysis of dissolved oxygen, argon and nitrogen. The system includes a sampler, chromatographic analysis for oxygen, argon and nitrogen, and three modes of calibration. The system was tested in the laboratory and at sea. Estimations of the composition of argon, oxygen and nitrogen in dry air and in air-saturated water are reported. Sea trials indicated that thermistor detectors should be used in the chromatograph instead of hot-filament detectors. (Knapp-USGS)
W70-07030

NUTRIENT CYCLING,
Yale Univ., New Haven, Conn. School of Forestry, and Dartmouth Coll., Hanover, N.H. Dept. of Biological Sciences.

F. H. Bormann, and G. E. Likens.

Science, Vol 155, No 3761, p 424-429, January 27, 1967. 3 fig, 1 tab, 21 ref. NSF Grants GB 1144 and GB 4169.

Descriptors: *Nutrients, *Cycling nutrients, *Small watersheds, Ecology, Energy budget, Food chains, Hydrologic cycle, Research and development, Reviews.

Identifiers: Experimental watersheds.

The small-watershed approach to problems of nutrient cycling has several advantages. The small watershed is a natural unit of suitable size for intensive study of nutrient cycling at the ecosystem level. It provides a means of reducing to a minimum, or virtually eliminating, the effect of the difficult-to-measure variables of geologic input and nutrient losses in deep seepage. Control of these variables makes possible accurate measurement of nutrient input and output (erosion) and therefore establishes the relationship of the smaller ecosystem to the larger biospheric cycles. The small-watershed approach provides a method whereby such important parameters as nutrient release from minerals (weathering) and annual nutrient budgets may be calculated. It provides a means of studying the interrelationships between the biota and the hydrologic cycle, various nutrient cycles, and energy flow in a single system. Finally, with the small-watershed system we can test the effect of various land-management practices or environmental pollutants on nutrient cycling in natural systems. (Knapp-USGS)
W70-07094

2L. Estuaries

SABINE RIVER AUTHORITY OF TEXAS, WATER QUALITY STUDY,
Forrest and Cotton, Inc., Dallas, Tex.
For primary bibliographic entry see Field 05A.
W70-06798

VARIATION OF THE LONGITUDINAL DISPERSION COEFFICIENT IN THE DELAWARE RIVER ESTUARY AS A FUNCTION OF FRESHWATER INFLOW,
Geological Survey, Philadelphia, Pa.

Richard W. Paulson.
Water Resources Research, Vol 6, No 2, p 516-526, April 1970. 11 p, 5 fig, 3 tab, 6 ref.

Descriptors: *Dispersion, *Estuaries, *Saline water intrusion, *Delaware River, *Mixing, Saline water, Saline water-freshwater interfaces, Mathematical models, Water quality, Monitoring.
Identifiers: Delaware estuary.

Three solutions of the one-dimensional steady state diffusion equation for a conservative substance have been derived for an estuary whose cross-sectional area increases linearly in the seaward direction. One solution results from the assumption that freshwater enters the estuary only at the upstream end. The two other solutions result from the assumption that freshwater inflow increases as a function of distance along the estuary. The latter two solutions are separated by different upstream boundary conditions. The three solutions have been tested with U. S. Geological Survey water quality monitor data from a reach of the Delaware estuary. The tests indicate that the longitudinal dispersion coefficient, which is assumed to be spatially constant at any particular time, increases with freshwater inflow from about 140 to 200 sq m/sec as the freshwater inflow at Trenton, New Jersey, increases from 2000 to 6000 cfs (60 to 180 cu m/sec). (Knapp-USGS)
W70-07000

Field 03—WATER SUPPLY AUGMENTATION AND CONSERVATION

Group 3A—Saline Water Conversion

03. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS,

Nebraska Univ., Lincoln.

William A. Scheller, and Carl E. Georgi.

Available from the Clearinghouse as PB-191 871, \$3.00 in paper copy, \$0.65 in microfiche. Nebraska University Water Resources Center Technical Completion Report, September 1, 1969. 24 p, 6 tab, 12 ref. OWRR Project No A-007-NEB.

Descriptors: *Desalination processes, *Electrodialysis, *Costs, *Nebraska, Brackish water, Brines, Saline water, Economics, Water supply, Water wells, Water resources development.

Identifiers: Desalination costs.

Samples obtained from four brackish wells in eastern Nebraska and two NaCl solutions were used in conjunction with laboratory electrodialysis unit to establish the process parameters necessary for estimating the cost of desalination. Investment and maintenance estimates for a 1000 GPD electrodialysis unit were also obtained. The cost of fresh water (500 ppm total solids) produced from brackish water (980 to 6460 ppm of total solids) was \$2.30 to \$7.78 per 1000 gallons including a 5% cost for investment capital. At a typical rural consumption of 60 gallons per person per day, the above fresh water costs are equivalent to 14 cents to 48 cents per person per day. These figures assume electric power is available at 3.3 cents/kwh, a typical rural Nebraska rate. If the electrodialysis unit were supplied with brackish water from an existing pressurized system and with reduced maintenance costs, the desalinated water costs would be reduced by 57 cents to \$1.59 per 1000 gallons, depending on the specific case. (Knapp-USGS)

W70-06755

3B. Water Yield Improvement

WATER USE, ADAPTABILITY, AND CHEMICAL COMPOSITION OF GRASSES SEEDED AT HIGH ELEVATIONS,

Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.

Ronald K. Tew.

Journal of Range Management, Vol 22, No 4, p 280-283, July 1969. 4 p, 2 tab, 7 ref.

Descriptors: *Evapotranspiration, *Water yield improvement, *Consumptive use, *Grasses, *Utah, Bromegrass, Orchardgrass, Wheatgrasses, Oats, Forage grasses, Range management, Forest management, Land management, Evapotranspiration control, Water conservation, Water loss.

Soil moisture depletion varied directly with extent of top and root growth of five grass species seeded on four areas between 6,500 and 8,500 ft in northern Utah. Smooth bromegrass and intermediate wheatgrass had greater root and top growth and used the most moisture at the lower elevation site where temperature were highest, but timothy and orchardgrass grew best at higher elevations; timothy contained low levels of nitrogen, phosphorus, and potassium on all sites, whereas tall oatgrass and orchardgrass contained high levels. (Knapp-USGS)

W70-06775

WATER OUT OF THE DESERT,

Washington State Univ., Pullman. Dept. of History. Christopher M. Wallace.

Southwestern Studies, Vol 6, No 2, University of Texas at El Paso, Monograph No 22, 1969. 48 p. 7 fig, 9 photo, 34 ref.

Descriptors: *Texas, *Municipal water, *Water supply, *Water shortage, *Water sources, Groundwater, Aquifers, Hydrogeology, Groundwater mining, Overdraft, Arid lands, Surface waters, Rio Grande, Water table, Drawdown, Saline water intrusion, Artesian wells, Subsurface waters, Groundwater basins, Wells, Hydraulic gradient, Rainfall, Evapotranspiration, Caliche, Water treatment, Drilling, Dissolved solids, Water hardness, Sewage treatment, History, Mexican Water Treaty.

Identifiers: *El Paso (Texas), *Hueco Bolson, Rio Grande Valley, Elephant Butte Reclamation Project, Santa Fe formation.

Growth and development of the El Paso, Texas, municipal water system are outlined in the monograph. Hydrogeology of the area is discussed with emphasis on such problems as groundwater depletion and saline water intrusion. Also included is the past, present and potential importance of the various local water-producing areas. Technological methods of obtaining water in the El Paso region and the influence of city policies on the water supply problem in El Paso are described. (Carr-Arizona)

W70-06824

WATER RESOURCES OF IOWA.

Iowa State Geological Survey, Iowa City.

For primary bibliographic entry see Field 06B.

W70-06981

GLACIERS OF THE CENTRAL CHILEAN ANDES AND THEIR IMPORTANCE TO THE WATER RESOURCES,

Geological Survey, Menlo Park, Calif.

For primary bibliographic entry see Field 02C.

W70-06989

INCREASES IN WATER YIELD FOLLOWING CLEAR-CUT LOGGING IN THE PACIFIC NORTHWEST,

US Forest Service (USDA), Corvallis, Oreg. Pacific Northwest Forest and Range Experimental Station.

Jack Rothacher.

Water Resources Research, Vol 6, No 2, p 653-658, April 1970. 6 p, 4 fig, 13 ref.

Descriptors: *Water yield improvement, *Clear-cutting, *Small watersheds, Forest management, Land clearing, Watershed management, Runoff, Water yield.

Identifiers: Cascade Range (Oregon).

Increases in water yield following timber harvest roughly conform to the proportion of the area cleared. In high precipitation areas of the Oregon Cascades, clear-cut logging can increase annual water yield 18 inches. Approximately 80% of the increase occurs during the October to March season. (Knapp-USGS)

W70-07007

PROTECTIVE SPRAY COATINGS FOR WATER HARVESTING CATCHMENTS,

Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.

Gary W. Frasier, and Lloyd E. Myers.

American Society of Agricultural Engineers, 1968 Summer Meeting, Logan, Utah, June 18-21 1968, Paper No. 68-234. 14 p, 1 fig, 1 tab, 4 ref.

Descriptors: *Water harvesting, *Paving, *Protective coatings, *Sealants, *Durability, Coatings, Paints, Linings, Spraying, Inhibitors, Waterproofing, Rubber, Soil asphalt, Asphalt, Construction materials, Colorimetry, Runoff, Rates of application, Costs, Failures, Deterioration, Emulsions.

Identifiers: *Catchments, *Discoloration, Photooxidation.

Low-cost protective coatings for improving durability of asphalt-paved water harvesting catchments were evaluated in laboratory and field studies. Degree of water discoloration was used as the indicator of pavement deterioration. Colorimetric procedures were used to measure discoloration of runoff water from two standard asphalt seal coats, two protective coatings, and a soil-stabilizing asphalt. Using RSK asphalt emulsion as standard, reduction in discoloration in the first year after application was 95% for rubberized aluminum paint, 70% for aluminized asphalt paint, and 54% for asphalt clay emulsion. MC-3 Venezuelan asphalt (derived from Venezuelan crude oil) discolored water 50 to 75% less than RSK asphalt (derived from California crude oil). On an operational water catchment the area treated with aluminum asphalt paint was in good condition after two and one-half years but the untreated asphalt had failed. The coatings are still experimental, but they are easy to apply and cost less than five cents per square yard. (Carr-Arizona)

W70-07058

3D. Conservation in Domestic and Municipal Use

URBAN AND INDUSTRIAL WATER SUPPLY: PROSPECTS AND POSSIBILITIES,

North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.

For primary bibliographic entry see Field 06D.

W70-06935

THE EMBATTLED COLOSSUS: NEW YORK CITY WATER SUPPLY SYSTEM, ITS PAST, PRESENT, AND FUTURE,

New York City Environmental Protection Administration.

Robert D. Clark.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968, p 25-33.

Descriptors: *Water supply, *New York, *Conservation, *Measurement, *Desalination, *Delaware River, Legal aspects.

Identifiers: *Hudson-Adirondack project, Catskill system, Croton system.

An historical view of New York's water supply system is given with emphasis on attempted means of augmenting the supply. The Catskill System first envisioned in 1904 and finally completed in 1927 had no sooner been finished than a new source was needed. Diversion of the Delaware followed but the drought of 1949-1950 indicated that the coming decades would require an even larger supply. Further diversion of the Delaware with the Cannonsville project was initially predicted to provide a supply sufficient until 2010. However, the northeast drought (1961-1967) had a horrendous effect on the New York Water Supply System. Survival of the drought was through conservation and management efforts which reduced average consumption by 25 per cent. New attempts to develop a Hudson-Adirondack project realized that a state or regional Commission was needed. Renovation of municipal departments to manage water as a total resource from mountain stream to sewer effluent led to the Department of Water Resources in the Environmental Protection Administration. Completion of the Cannonsville Reservoir and building of the Richmond tunnel on Staten Island are reviewed as is construction of a third tunnel to augment present city facilities in the Croton System. A Federal study of desalination suggests that this may play a role in the future in solving local water supply problems. Finally, the need for universal metering and problems involved in this task are reviewed. (Preckwinkle-Chicago)

W70-06939

WATER FOR CITIES,

Corps of Engineers, Washington, D.C.

For primary bibliographic entry see Field 06B.

W70-06940

METROPOLITAN AREA WATER RESOURCE PROBLEMS,
Rutgers - The State Univ., New Brunswick, N.J.
Water Resources Research Inst.
For primary bibliographic entry see Field 06B.
W70-06941

CONTEMPORARY DEVELOPMENTS IN WATER LAW.
For primary bibliographic entry see Field 06E.
W70-07095

A MODEL WATER USE ACT FOR A RIPARIAN STATE—THE FLORIDA EXPERIENCE,
For primary bibliographic entry see Field 06E.
W70-07096

PUBLIC RIGHTS IN PUBLIC RESOURCES: THE CITIZEN'S ROLE IN CONSERVATION AND DEVELOPMENT,
For primary bibliographic entry see Field 06E.
W70-07015

3E. Conservation in Industry

CONTEMPORARY DEVELOPMENTS IN WATER LAW.
For primary bibliographic entry see Field 06E.
W70-07095

A MODEL WATER USE ACT FOR A RIPARIAN STATE—THE FLORIDA EXPERIENCE,
For primary bibliographic entry see Field 06E.
W70-07096

3F. Conservation in Agriculture

AUTOMATION OF IRRIGATION SYSTEMS,
Nebraska Univ., Lincoln. Dept. of Agricultural Engineering.
Paul E. Fishbach.

Paper presented at 155th Meeting of Missouri Basin Interagency Committee, State Capitol Building, Lincoln, Nebraska, December 10-12, 1968. 13p, 10 fig, 3 ref.

Descriptors: *Irrigation systems, *Automatic control, *Water reuse, Irrigation efficiency, Irrigation practices, Crop response, Water delivery.
Identifiers: Automatic irrigation control.

Two experimental surface irrigation systems operating with a reuse system are described. An automated surface irrigation system with reuse system was installed during 1966 at the University of Nebraska Field Laboratory, Mead, Nebraska, and has been operated three irrigation seasons. An irrigation well with an electrically powered pump rated at 1200 gallons per minute was utilized as the water source. Runoff from 2 fields drains into a common drainage ditch which outlets into a collection pit. An electrically driven reuse pump was installed in the collection pit to pump the runoff water back into the main water supply line. Automatically controlled irrigation valves were used on the risers of the buried pipeline. The second automated surface irrigation system with a reuse system was installed during 1968 at the University of Nebraska Field Laboratory, Mead, Nebraska. This system utilized the same irrigation well, buried pipeline to the head of the field and, air compressor. The corn irrigated with the automated surface irrigation system produced 180 bushels per acre. Water use efficiencies varied from 86 to 94%. The estimated cost of System No. 1 is about \$18,000 for 160 acres and on System No. 2 the estimated cost is \$10,000 per 160 acres. (Knapp-USGS)

W70-06797

CENTURY ONE, 1869-1969, ONE HUNDRED YEARS OF WATER DEVELOPMENT IN THE SALT RIVER VALLEY,
Stephen C. Shadegg.
Stephen C. Shadegg, Phoenix, Arizona, 1969. 48p

Descriptors: *Arizona, *History, *Reclamation states, *Arid lands, *Irrigation, Arid climates, Economic impact, Agriculture, Hydroelectric power, Water storage, Urbanization, Reservoir storage, Federal Reclamation Act, Drought, Water rights, Dams, Multiple-purpose projects.

Identifiers: *Salt River, *Salt River Valley, *Salt River Project, *Central Arizona, *Salt River Valley Water Users' Association, Irrigated agriculture, Kibbey plan.

The basic history of the Phoenix area is outlined, with particular attention on the growth of irrigated agriculture. The life of the Salt River Project is the major interest of the monograph, which goes into detail of irrigation in the Salt River Valley, passage of the National Reclamation Act of 1902, organization of the Salt River Valley Water Users' Association in 1903 and its growth to the present. Changes in orientation toward urban and industrial water use are mentioned, as is the influence of the project on the economic development of Arizona. (Carr-Arizona)
W70-06807

ARTIFICIAL SELECTION FOR SEEDLING DROUGHT TOLERANCE IN BOER LOVEGRASS (ERAGROSTIS CURVULA NEES),
Arizona Univ., Tucson. Dept. of Agronomy; and Agricultural Research Service. Tucson, Ariz. Crops Research Div.
For primary bibliographic entry see Field 021.
W70-06809

WATER REQUIREMENTS IN STRAINS OF VINE-MESQUITE (PANICUM OBTUSUM H. B. K.),
New Mexico State Univ., University Park. Dept. of Agronomy.
For primary bibliographic entry see Field 021.
W70-06812

WATER-USE EFFICIENCY AND ITS ASSOCIATION WITH SEVERAL CHARACTERISTICS OF BLUE PANICGRASS (PANICUM AN-TIDOTALE RETZ.) CLONES,
Arizona Univ., Tucson. Dept. of Agronomy; and Agricultural Research Service, Tucson, Ariz. Crops Research Div.
For primary bibliographic entry see Field 021.
W70-06814

CORN YIELDS, SOIL TEMPERATURE, AND WATER USE WITH FOUR TILLAGE METHODS IN THE WESTERN CORN BELT,
Agricultural Research Service, Brookings, S. Dak. Corn Belt Branch; and South Dakota Agricultural Experiment Station, Brookings.
For primary bibliographic entry see Field 021.
W70-06817

INTRODUCTION OF HYDROPONICS IN COLORADO: TECHNIQUE AND IMPLICATIONS IN A SEMI-ARID REGION,
Colorado State Univ., Fort Collins. Dept. of Horticulture.
Joe J. Hanan, and W. D. Holley.

Agricultural Meteorology, Vol 7, No 1, p 29-38, January 1970. 5 fig, 27 ref.

Descriptors: *Hydroponics, *Greenhouses, *Water resources, *Arid lands, *Colorado, Semiarid climates, Arid climates, Environment, Agriculture, Horticulture, Plants, Consumptive use, Water utilization, Evapotranspiration, Irrigation, Irrigation programs, Water conservation, Water pollution, Water quality, Waste water (Pollution), Pollution abatement, Saline water.
Identifiers: *Carnations, Solar regimes.

Use of hydroponics in the greenhouse industry has never been widely practiced. Recently, however, plant cultivation in inert substrates has gained widespread acceptance in Colorado. The basic technique in use there for growing carnations is described and illustrated. It is pointed out that, even when grown in soil, a single carnation cut flower probably uses 3.41 of water during its development. Evidence indicates that growth by hydroponics may double the water requirement per flower. Thus, although arid regions offer solar regimes most suited for greenhouse production using inert media, introduction of hydroponics would put increasing pressures on water resources. Also, more frequent water cycling required by this method would produce additional waste water, which would lead to increased pollution problems. The total picture indicates that even though saline water could possibly be utilized in a hydroponic system, no significant returns to arid lands in pollution abatement or water conservation appear likely. (Carr-Arizona)
W70-06818

EFFICIENCY OF WATER USE AND SEEDLING DROUGHT TOLERANCE OF BOER LOVEGRASS, ERAGROSTIS CURVULA NEES,
Arizona Univ., Tucson. Dept. of Agronomy; and Agricultural Research Service, Tucson, Ariz. Crops Research Div.
For primary bibliographic entry see Field 021.
W70-06819

WATER IMPORT SYSTEMS FOR ARID LAND DEVELOPMENT,
Parsons (Ralph M.) Co., Los Angeles, Calif. Charles Poll.

Symposium on Increasing Food Production in Arid Lands, Texas Tech College, Lubbock, International Center for Arid and Semi-Arid Land Studies, Publication No. 3, p 43-54, 1969. 3 fig.

Descriptors: *Water transfer, *Interbasin transfer, *Arid lands, *Mexico, *United States, Water conveyance, Canals, Reservoirs, Reservoir storage, Pumped storage, Water delivery, Irrigation, Electric power, Electric power production, Hydroelectric plants, Thermal powerplants, Economic feasibility, Industrial water, Municipal water, Mississippi River.

Identifiers: *Canada, *North America, *American Desert, *NAWAPA (North American Water and Power Alliance), *MUSHEC (Mexican-United States Hydroelectric Commission), Rocky Mountain Trench, Irrigated agriculture.

The American Desert is one of the few large areas in the world in which conditions are favorable for irrigated agriculture on a massive scale. Among the proposals for importing water into this area are two plans known as NAWAPA (North American Water and Power Alliance) and MUSHEC (Mexico-United States Hydroelectric Commission). NAWAPA would collect and store water from the northwestern portion of the North American continent and distribute it via canals and tunnels to parts of Canada, the United States, and Mexico. The system would handle 158,000,000 acre feet of water per year and would have a total installed power generating capacity of 110,000,000 kilowatts. The MUSHEC system envisions utilizing flood waters from the Mississippi River and from the Isthmus of Tehuantepec region of the Sierra Madre Oriental. Canals, pipes, and tunnels would distribute 129,000,000 acre feet per year to northern Mexico and parts of Kansas, Oklahoma, New Mexico, and Texas. Preliminary studies of NAWAPA indicate that the project is economically feasible. Economic aspects of MUSHEC have not yet been studied. (Carr-Arizona)
W70-06821

UTILIZATION AND MANAGEMENT OF WATER IN THE ARID ZONES OF MEXICO (IN SPANISH),
Instituto Tecnológico y de Estudios Superiores de Monterrey (Mexico). Departamento de Suelos e Irrigacion.

Field 03—WATER SUPPLY AUGMENTATION AND CONSERVATION

Group 3F—Conservation in Agriculture

For primary bibliographic entry see Field 021.
W70-06825

THE INTEGRATED USE OF GROUND AND SURFACE WATER IN IRRIGATION PROJECT PLANNING,

Harvard Univ., Cambridge, Mass. Center for Population Studies.

Peter Rogers, and Douglas V. Smith.

American Journal of Agricultural Economics, Vol. 52, No. 1, p. 13-24, Feb. 1970. 12 p, 5 fig, 5 tab, 13 ref.

Descriptors: *Project planning, *Irrigation design, *Linear programming, Surface-groundwater relationships, Drainage, Water requirements, Water management (Applied).

A linear programming model determines water balances for a project area. Interactions of a surface water-groundwater system within the economic context of irrigation management are emphasized. Tubewell, canal and surface drainage capacities, the project size, and cropping pattern are all selected by the linear program. The program is designed within the constraints on continuity at the river; capacity of the canals, tubewells, and drainage channels; mining of groundwater; crop water requirements; availability of land of different soil types; and permissible crop patterns. An example of irrigation planning by linear programming is included. (Grossman-Rutgers)

W70-06837

RECHARGE OF GROUNDWATER FROM RENOVATED SEWAGE EFFLUENT BY SPRAY IRRIGATION,

Pennsylvania State Univ., University Park. Dept. of Geology and Geophysics.

For primary bibliographic entry see Field 04B.
W70-06953

ECONOMICS OF IRRIGATION SYSTEM CONSOLIDATION,

Colorado State Univ., Fort Collins. Dept. of Economics.

Paul C. Huszar, D. W. Seckler, and D. D. Rohdy. Colorado State University Experiment Station, Technical Bulletin 105, Dec. 1969. 50 p, 25 tab, 11 fig, 7 append, 23 ref.

Descriptors: *Consolidation, *Irrigation ditches, *Economic feasibility, Welfare (Economics), Mathematical studies, Systems analysis.

Identifiers: *Northern Colorado Water Conservancy District No. 3.

Possible economics resulting from complete or partial consolidation of the system of irrigation ditches located in the Northern Colorado Water Conservancy District No. 3 are examined. Three consolidation plans were studies to determine whether or not any of them are economically feasible. Their operations were simulated in order to make comparisons between the alternative schemes. The alternative plans were ranked according to preference with respect to both upper and lower irrigation systems. Preference ordering of the entire system were then derived. To perform the ranking, simultaneous confidence intervals, in terms of future benefits and costs, were used. The maximum welfare of the entire system was used as the basic criterion. (Grossman-Rutgers)

W70-06956

DISSIPATION OF ENDOTHALL AND EFFECTS ON AQUATIC WEEDS AND FISH,

California Univ., Davis. Dept. of Botany.

R. R. Yeo.

Weed Science, Vol 18, No 2, p 282-284, 1970. 4 tab, 5 ref.

Descriptors: *Herbicides, *Aquatic weeds, Fish, Calcium chloride, Farm ponds.

Identifiers: *Endothall, Lethal effects, Plastic growth pools, Elodea canadensis, Duckweed, Nitella, Chara, American elodea, Mosquitofish.

Fourteen farm ponds and water in small plastic growth pools were treated with sodium and potassium salts of endothall applied at rates from 0.3 to 4.0 ppm. The chemical controlled pond weeds with the exception of American elodea, common duckweed, nitella, and chara. Smallmouth bass and sunfish survived the treatment, but some mosquitofish, especially females, were killed in growth pools. The decrease in concentration of endothall averaged 71% during 12 days. Addition of calcium chloride failed to exert significant influence, partially because of the amount of chemical applied was too small to produce an appreciable ecological change of water. (Wilde-Wisconsin)
W70-06971

AGRICULTURAL DEVELOPMENT IN NORTHERN MEXICO, 1940-1960,

Stanford Univ., Calif.

W. Whitney Hicks.

Land Economics, Vol 43, No 4, p 393-402, November 1967. 1 fig, 1 tab, 16 ref.

Descriptors: *Mexico, *Crop production, *Irrigated land, *Cotton, *Wheat, Irrigation programs, Irrigation effects, Irrigation, Land use, Farm prices, Crops, Tomatoes, Strawberries, Melons, Economics, Foreign countries, Government, Federal government, Government supports, Arid lands, Agriculture, Credit.

Identifiers: *Northern Mexico, *Agricultural development, *Irrigated agriculture, Labor productivity, Mechanization.

The rapid increase in crop production in northern Mexico between 1940 and 1960 is analyzed. During this period agricultural production in the area grew at an annual rate of 9%, compared to 5% for the Gulf of Mexico and Pacific South regions and 3% for the Central region. One factor influencing rapidly rising crop production was the high rate of growth of cotton and wheat, which are primarily grown in the North and Pacific North census regions. As of 1960, these two regions produced 99% of the cotton in Mexico, 71% of the wheat, and 65% of the melons, tomatoes, and strawberries. Other factors influencing growth of crop production include favorable prices, higher labor productivity, irrigation development, mechanization, and differences in landholding systems. Irrigated land in northern Mexico grew at a rate of 4.1% yearly between 1940 and 1960 and constituted approximately 75% of the total increase in irrigated land in Mexico. Over half of the irrigation projects in the area were government-constructed. Such data support the thesis that development of the cotton and wheat crop in Mexico has depended to a large degree on decisions of the Mexican government as to whether and where to build irrigation works. (Carr-Arizona)

W70-07052

ENVIRONMENTAL EFFECTS OF IRRIGATION IN THE CENTRAL VALLEY OF ARIZONA,

Arizona Univ., Tucson. Dept. of Agricultural Engineering; and Arizona Univ., Tucson. Dept. of Agricultural Economics.

For primary bibliographic entry see Field 06G.

W70-07053

INFLUENCE OF SUBSURFACE IRRIGATION ON COTTON YIELDS AND WATER USE,

New Mexico State Univ., University Park. Dept. of Agricultural Engineering; and New Mexico State Univ., University Park. Dept. of Agronomy.

For primary bibliographic entry see Field 021.

W70-07056

04. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control of Water on the Surface

SEEPAGE INVESTIGATION OF MEDINA CANAL, BEXAR-MEDINA-ATASCOSA COUNTIES, TEXAS, WATER IMPROVEMENT DISTRICT NO 1 CANAL SYSTEM, AUGUST 15, 1969,

Geological Survey, Austin, Tex.

Larry F. Land.

Geological Survey Open-file report (dupl), April 1970. 5 p, 1 fig, 1 tab, 1 ref.

Descriptors: *Canal seepage, *Evapotranspiration, *Water loss, *Canals, *Texas, Surface-groundwater relationships, Infiltration, Discharge (Water), Streamflow.

Identifiers: Medina Canal (Texas).

Measurements of flow in the Medina Canal, Texas on August 15, 1969, showed a loss of 4 cfs in a 24-mile reach between the gaging station near Riomedina and a measurement site near Pearson. Although the canal bed material is primarily earthen, except for about one-half mile of concretelined channel at the upper end of the study reach, no significant losses were found. Most of the decrease in flow (106 to 102 cfs) is attributed to evaporation and transpiration. (Knapp-USGS)
W70-06745

ESTIMATION MONTHLY STREAMFLOWS WITHIN A REGION,

Corps of Engineers, Sacramento, Calif. Hydrologic Engineering Center.

Leo R. Beard, Augustine J. Fredrich, and Edward F. Hawkins.

Hydrologic Engineering Center Technical Paper No 18, U S Army Corps of Engineers, Sacramento, California, Jan, 1970. 14 p, 3 fig.

Descriptors: *Streamflow forecasting, *Estimating, *Synthetic hydrology, Water resources development, Runoff forecasting, Data processing, Computer programs, Mathematical models, Mathematical studies.

Identifiers: *Peru.

Techniques developed in The Hydrologic Engineering Center of the Corps of Engineers for reconstituting missing portions of monthly streamflow data are being tested by applications in the Pacific coastal area of Peru. To develop the coordinated set of streamflow records, a base period of 50 years was selected, and missing monthly streamflow data were estimated at each of the 60 gaged locations, using regional analysis and correlation with appropriate physical and hydrologic characteristics. From this complete set of streamflow records, concurrent values for each of the 40 remaining ungauged locations will be estimated. Monthly streamflow quantities are produced to enable the Peruvian government to evaluate water resources developments along the western coast, and provide information for comparison of alternative schemes of development. (Knapp-USGS)
W70-06747

ANNUAL PEAK DISCHARGES FROM SMALL DRAINAGE AREAS IN MONTANA THROUGH SEPTEMBER 1969,

Geological Survey, Helena, Mont.

For primary bibliographic entry see Field 02E.

W70-06752

ZIMMERMAN V UNION PAVING CO (OBSTRUCTION OF PIPE CONVEYING SPRING

Control of Water on the Surface—Group 4A

WATERS).

6 A2d 901-905 (Penn 1939).

Descriptors: *Pennsylvania, *Springs, *Water conveyance, *Excavation, Right-of-way, Water rights, Judicial decisions, Legal aspects, Spring waters, Seepage, Prescriptive rights, Damages, Relative rights, Competing uses, Gravitational water, Alteration of flow, Obstruction to flow, Land tenure, Pipes, Pipelines.

A deed gave plaintiff a right to conduct water through a pipe from a designated spring on land retained by his grantor and a right to use water from an unnamed spring thereon. Plaintiff conveyed water from both springs through pipes to his property for over eight years. Defendant, who had acquired a right to remove soil from the grantor's land, was warned of the likely result if excavation was continued in the vicinity of the unnamed spring. Subsequently, because of continued excavation, the water flow through the plaintiff's pipe from the unnamed spring was halted and plaintiff had to transport the water from the unnamed spring by hand. Plaintiff's action to recover for the interference with his property right in the unnamed spring resulted in a favorable judgment. The Pennsylvania Supreme Court, in reversing for defendant, held that where a deed expressly grants plaintiff a right to conduct water from a designated spring on his grantor's land through a pipe to plaintiff's premises, but merely gives plaintiff the right to get his water from an unnamed spring, such deed inferentially precludes the right to convey water from the unnamed spring by the use of a pipe. Also plaintiff's use of a pipe from the unnamed spring for several years had not created an easement by prescription but merely a license and defendant's acts had not deprived plaintiff of a property right. (Powell-Florida)
W70-06757

FLOOD PLAIN INFORMATION, BOULDER CREEK AND SOUTH BOULDER CREEK: VOLUME II - BOULDER METROPOLITAN REGION, COLORADO.

Corps of Engineers, Omaha, Nebr.

Corps of Engineers Flood Plain Report, August 1969. 34 p, 13 plate, 9 tab.

Descriptors: *Floods, *Flood damage, *Colorado, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood, Historic flood. **Identifiers:** Boulder (Colo), Standard project flood, Intermediate regional flood.

Flooding of Boulder, Colorado is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06767

FLOOD PLAIN INFORMATION, TUALATIN RIVER AND TRIBUTARIES, WASHINGTON COUNTY, OREGON.

Corps of Engineers, Portland, Oreg.

Corps of Engineers Flood Plain Report, June 1969. 71 p, 9 fig, 72 plate, 23 tab.

Descriptors: *Floods, *Flood damage, *Oregon, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood. **Identifiers:** Tualatin River (Oreg), Standard project flood, Intermediate regional flood.

Flooding of the Tualatin River, Washington County, Oregon is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06773

FLOOD PLAIN INFORMATION ON MAIN STEM AND SOUTH BRANCH BIG TIMBER CREEK IN CAMDEN AND GLOUCESTER COUNTIES, NEW JERSEY.

Corps of Engineers, Philadelphia, Pa.

Corps of Engineers Flood Plain Report, March 1969. 49 p, 4 fig, 16 plate, 12 tab.

Descriptors: *Floods, *Flood damage, *New Jersey, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood, Historic flood.

Identifiers: Camden County (NJ), Gloucester County (NJ).

Flooding of Big Timber Creek, Camden and Gloucester Counties, New Jersey is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06777

FLOOD PLAIN INFORMATION, CHRISTINA RIVER, EAST AND WEST BRANCHES, NEWARK, NEW CASTLE COUNTY, DELAWARE.

Corps of Engineers, Philadelphia, Pa.

Corps of Engineers Flood Plain Report, May 1969. 45 p, 9 fig, 14 plate, 9 tab.

Descriptors: *Floods, *Flood damage, *Delaware, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood.

Identifiers: Christina River (Del), Standard project flood, Intermediate regional flood.

Flooding of the Christina River, East and West Branches, Newark, Delaware is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06781

FLOOD PLAIN INFORMATION OF UMATILLA RIVER IN MISSION - RIVERSIDE AREA NEAR PENDLETON, OREGON.

Corps of Engineers, Walla Walla, Wash.

Corps of Engineers Flood Plain Report, November 1969. 31 p, 10 fig, 11 plate, 2 tab.

Descriptors: *Floods, *Flood damage, *Oregon, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood, Historic flood.

Identifiers: Mission (Ore), Riverside (Ore), Standard project flood, Intermediate regional flood.

Flooding of the Umatilla River in the Mission - Riverside area, Oregon is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06785

FLOOD PLAIN INFORMATION, SOUTH FORK EEL RIVER, PHILLIPSPVILLE TO GARBerville, HUMBOLDT COUNTY, CALIFORNIA.

Corps of Engineers, San Francisco, Calif.

Corps Engineers Flood Plain Report, June 1969. 35 p, 7 fig, 22 plate, 8 tab.

Descriptors: *Floods, *Flood damage, *California, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood, Historic flood. **Identifiers:** *Humboldt County (Calif).

Flooding of the South Fork Eel River, Humboldt County, California is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06786

FLOOD PLAIN INFORMATION, CALLEGUAS CREEK, VENTURA COUNTY, CALIFORNIA.

Corps of Engineers, Los Angeles, Calif.

Corps of Engineers Flood Plain Report, September 1969. 59 p, 34 fig, 45 plate, 8 tab.

Descriptors: *Floods, *Flood damage, *California, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood, Historic flood. **Identifiers:** *Ventura County (Calif), Standard project flood, Intermediate regional flood.

Flooding of Calleguas Creek, Ventura County, California is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06787

MAXIMUM UTILIZATION OF SCARCE DATA IN HYDROLOGIC DESIGN,

Corps of Engineers, Sacramento, Calif. Hydrologic Engineering Center.

For primary bibliographic entry see Field 07C.

W70-06788

FLOOD PLAIN INFORMATION, BARTON, MILL, AND STONE CREEKS, BOUNTIFUL,

Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

Group 4A—Control of Water on the Surface

WEST BOUNTIFUL, AND WOODS CROSS, UTAH.
Corps of Engineers, Sacramento, Calif.

Corps of Engineers Flood Plain Report, December 1969. 35 p, 16 fig, 12 plate, 8 tab.

Descriptors: *Floods, *Flood damage, *Utah, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood.

Identifiers: *Davis County (Utah), Standard project flood, Intermediate regional flood.

Flooding in Bountiful, West Bountiful, and Woods Cross, Utah is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W70-06789

EVALUATING HERBICIDES AGAINST AQUATIC WEEDS,
Agricultural Research Service, Fort Lauderdale, Fla., Crops Research Div.
Robert D. Blackburn.
Weeds, Vol 11, No 1, p 21-24, January 1963. 4 p, 2 fig, 4 tab, 10 ref.

Descriptors: *Herbicides, *Aquatic weeds, *Weed control, *Aquatic weed control, Diquat (2-4-D), Alligatorweed, Toxicity, Surface waters.
Identifiers: Herbicide effectiveness, Acrolein, Silvex.

Techniques were developed for evaluating herbicides on submersed, floating, and emerged aquatic weeds. Among 75 herbicides evaluated on three species of submersed weeds only diquat, paraquat, endothal, and acrylaldehyde (acrolein) gave 85% or better control at 1 ppmw in still-water tests. Only acrolein and endothal were effective on submersed weeds at 1 ppmw in the limited-exposure test. The evaluation of 17 herbicides on three species of floating aquatic weeds indicated that diquat was effective when applied at rates of 1 or 2 lb/A. The tertiary fatty acid amine of 2,4-D were more effective on floating weeds than an ester of 2,4-D. Many of the 78 herbicides evaluated on alligatorweed killed the tops, but only two retarded the sprouting of underwater nodes longer than 6 weeks. Applications of 20 lb/A of silvex in two formulations retarded sprouting of underwater nodes for 8 weeks. (Knapp-USGS)
W70-06805

CENTURY ONE, 1869-1969, ONE HUNDRED YEARS OF WATER DEVELOPMENT IN THE SALT RIVER VALLEY,
For primary bibliographic entry see Field 03F.
W70-06807

WATER IMPORT SYSTEMS FOR ARID LAND DEVELOPMENT,
Parsons (Ralph M.) Co., Los Angeles, Calif.
For primary bibliographic entry see Field 03F.
W70-06821

WATER OUT OF THE DESERT,
Washington State Univ., Pullman. Dept. of History.
For primary bibliographic entry see Field 03B.
W70-06824

SLATTEN V MITCHELL (SUIT TO ENJOIN UPHILL LANDOWNER FROM BUILDING BARRIER TO KEEP DRAINAGE WATER OFF HIS LAND).

124 SW2d 310-320 (Tenn Ct App 1938).

Descriptors: *Tennessee, *Repulsion (Legal aspects), *Drainage systems, *Relative rights, Natural flow, Surface water, Ditches, Easements, Prescriptive rights, Land tenure, Drainage, Barriers, Flood protection, Remedies, Dams, Diversion structures, Legal aspects, Sinks, Judicial decisions, Obstruction to flow, Drainage water, Surface runoff, Walls, Ditches.

Plaintiffs sought to enjoin defendants from building a wall along a drainage ditch running through plaintiff's and defendants' properties. Although defendants left a gap in the wall to allow excess water to flow into a sink on defendants' land, plaintiffs claimed that the effect of the wall was to keep the drainage water from flowing onto defendants' uphill property and to cast an abnormally large amount of surface runoff onto plaintiffs' downhill lands. After holding that the common enemy doctrine, whereby a landowner may dispose of surface water as best he can, was not in force in Tennessee, the court stated that a landowner could protect his property from injury by surface water if the rights of others were respected. The court held that because much of the water was put into the ditch by lateral ditches uphill from defendants' property, defendants had the right to take reasonable steps to keep the runoff from overflowing their land. Plaintiffs were held to have no prescriptive right to have the drainage water diverted onto defendants' property, and the complaint was dismissed. (Caldwell-Florida)
W70-06870

BEAUTON V CONNECTICUT LIGHT AND POWER CO (FLOODING, AN ACT OF GOD).
3 A 2d 315-319 (Conn 1938).

Descriptors: *Connecticut, *Dams, *Floods, *Impounded waters, Water rights, Flood damage, Judicial decisions, Legal aspects, Historic flood, Flood gates, Flood protection, Control structures, Dam failure, Overflow, Rain water, Water injury, Rivers, Floodways, Dam construction, Concrete structures, Downstream, Snowmelt, Impoundments, Utilities.

Plaintiffs, lower stream proprietors, owned cottages about a mile below a dam owned by the defendant utility company. Plaintiffs' cottages were destroyed when heavy rains and melting snow flooded the valley. Plaintiffs sought recovery for property damage resulting from the alleged negligent construction and operation of defendant's dam. Defendant contended the damage was caused by an act of God - an unprecedented flood. The Connecticut Supreme Court affirmed a decision for defendant although acknowledging that an upper stream proprietor has no right to gather and impound waters and then suddenly release them on the land of the lower proprietors. It is the common right of all to have the stream preserved in its natural size, flow and purity without material diversion. In order to recover, the plaintiffs had to prove that the defendant substantially accelerated the flow of the water beyond the natural capacity of the stream banks. They could not recover if the waters that flowed over the dam were the same in quantity as had entered. (Powell-Florida)
W70-06875

URBAN DRAINAGE PRACTICES, PROCEDURES, AND NEEDS,
American Public Works Association, Chicago, Ill.
Herbert G. Poertner, Dr. Karl W. Wolf, and Robert L. Anderson.

Special Report No 31, Project 119, December 1966. 54 p, 2 fig, 22 tab, 9 ref, bibliography.

Descriptors: *Drainage practices, *Surface drainage, *Watershed management, *Urbanization, *Cities, *Administrative agencies, *Management, *Administration, *Drainage districts, Drainage systems, Drainage water, Storm runoff, Flood control, Legislation.
Identifiers: *Urban drainage.

This report, produced under the direction of the Urban Drainage Committee of the American Public Works Association, presents factual information on flood protection and drainage practices and policies of urban areas, with emphasis on the planning, regulatory and financing aspects. The fact-finding investigations were generally confined to the areas of management and administration. A questionnaire containing 66 questions was mailed, in 1965, to each community of the United States and Canada having populations in excess of 10,000 persons. Responses were received from 627 communities. The data received was summarized in 22 tables, by population groups, to express the percentage of communities in each population group that have adopted specific practices and policies in drainage management and administration. Tabulations of data were further broken down to depict practices and policies in communities having legally adopted drainage districts. The tables are presented under five chapter headings: (1) general information, (2) organizational patterns for urban drainage management, (3) financing of capital improvements, (4) planning and regulatory functions, and (5) design, construction and maintenance. Nineteen research projects are suggested. An extensive annotated bibliography on urban drainage and flood control is included. (Poertner-Chicago)
W70-06920

POTENTIAL IMPACT OF TUNNELS ON WATER POLLUTION AND FLOOD CONTROL IN THE CHICAGO AREA,
Metropolitan Sanitary District of Greater Chicago, Ill.

For primary bibliographic entry see Field 05G.
W70-06926

THE USE OF URBAN UNDERGROUND SPACE IN STORM WATER MANAGEMENT IN CHICAGO,
Harza Engineering Co., Chicago, Ill.
For primary bibliographic entry see Field 05G.
W70-06942

CHARACTERIZATION AND CONTROL OF OVERFLOWS FROM COMBINED SEWERS,
Engineering-Science, Inc., Forest Hills, N.Y.; and Engineering-Science, Inc., Arcadia, Calif.
For primary bibliographic entry see Field 05G.
W70-06943

MANAGEMENT OF IOWA'S WATER RESOURCES,
Office of Water Resources Research, Washington, D.C.
For primary bibliographic entry see Field 06B.
W70-06988

A FACTOR ANALYSIS OF RESERVOIR LOSSES,
Agricultural Research Service, Riesel, Tex. Soil and Water Conservation Research Div.
Walter G. Knisel, Jr.
Water Resources Research, Vol 6, No 2, p 491-498, April 1970. 8 p, 3 fig, 4 tab, 11 ref.

Descriptors: *Reservoir leakage, *Karst, *Texas, Limestones, Caves, Seepage, Statistical methods, Water storage, Groundwater movement, Water levels, Water level fluctuations, Surface-groundwater relationships.
Identifiers: Factor analysis.

Analyses of loss rates from five floodwater detention reservoirs in cavernous terrain are presented. Thirteen variables were included in a factor analysis to determine those significant for estimating reservoir loss rates. Three variables were found to be significant for one reservoir, but the accuracy of estimate of loss rate was not significantly greater than for reservoir stage alone. Loss rates are related arithmetically and by power functions to reservoir stage. The amount of variance explained

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by reservoir stage ranges from 54% to 90%. Loss rates ranged up to 4.5 acre feet per hour for the five reservoirs. (Knapp-USGS)
W70-06997

THE 3-PARAMETER LOGNORMAL DISTRIBUTION AND ITS APPLICATIONS IN HYDROLOGY,
Department of Energy, Mines and Resources, Ottawa (Ontario), Inland Waters Branch.
For primary bibliographic entry see Field 02E.
W70-06999

A STATISTICAL COMPARISON OF MEANDER PLANFORMS IN THE WABASH BASIN,
Purdue Univ., Lafayette, Ind.
T. P. Chang, and G. H. Toebes.
Water Resources Research, Vol 6, No 2, p 557-578, April 1970. 21 p, 13 fig, 3 tab, 32 ref. OWRR Project No A-003-IND.

Descriptors: *Meanders, *Alluvial channels, *Statistical methods, Model studies, Hydraulic models, Open channel flow, Geomorphology, Probability.
Identifiers: Spectral analysis, Wabash River (Indiana).

The planforms of two natural meandering rivers, the Wabash River and the White River in Indiana, were investigated using a variety of statistical techniques. Local curvature series were used as the basic statistical descriptor of the planform. Two groups of factors, (1) geology and soil and (2) flow rate and channel slope, were found to be major factors that control the meander planform. This conclusion was supported by probability distribution as well as by time series analysis studies. A method of moving spectrums was developed for the analysis of nonstationary data that are typical in geomorphology. This method was applied to the curvature series of the White and Wabash rivers. It appears to provide an objective way to describe local statistics of the meander shape. (Knapp-USGS)
W70-07003

HODOGRAPH SOLUTION OF THE DRAINAGE PROBLEM WITH VERY SMALL DRAIN DIAMETER,
Agricultural Research Council, Cambridge (England). Unit of Soil Physics.
E. G. Youngs.
Water Resources Research, Vol 6, No 2, p 594-600, April 1970. 7 p, 3 fig, 2 tab, 11 ref.

Descriptors: *Drainage, *Soil water movement, *Groundwater movement, *Subsurface drainage, Drawdown, Capillary water, Drainage systems, Mathematical studies.
Identifiers: Hodographs.

The hodograph treatment of the drainage problem of uniform vertical fluxes draining to a system of parallel equally spaced cylindrical drains laid in an infinitely deep soil is applied to the case of very small drains. A simple approximate expression allowing the inclusion of the effect of the capillary fringe thickness is derived for the drain radius. Computed results are presented, and these are used in the discussion of experimental results for systems of gappy drains laid in a hydraulic model sand tank. (Knapp-USGS)
W70-07006

SEEPAGE FROM TRAPEZOIDAL CHANNELS,
Uttar Pradesh Irrigation Research Inst., Roorkee (India).
Satya P. Garg, and A. S. Chawla.
ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY6, Paper 7335, p 1261-1281, June 1970. 21 p, 15 fig, 3 tab, 17 ref. append.

Descriptors: *Canal seepage, *Water levels, *Groundwater movement, *Surface-groundwater relationships, Open channels, Drainage, Flow nets, Mapping, Analytical techniques.

Identifiers: Conformal mapping.

The general problem of seepage from trapezoidal channels in homogeneous and isotropic material with drainages at a finite distance from the canal and at a finite depth is solved exactly by the use of conformal mapping. Equations for seepage discharge and the shape of the free surface are given and solved numerically. The results are given in the form of easy-to-use curves. The analysis indicates that the phreatic surface has a continuous curve from the canal to the drain. This surface rises with increase in bed width, water depth and drainage distance, though the effect of side slopes is very little. The seepage discharge increases with an increase in bed width, water depth, side slopes, and with a decrease in the drainage distance. (Knapp-USGS)
W70-07016

OHIO SURFACE WATER RIGHTS,
For primary bibliographic entry see Field 06E.
W70-07063

EFFECTS OF FOREST COVER UPON HYDROLOGIC CHARACTERISTICS OF A SMALL WATERSHED IN THE LIMESTONE REGION OF EAST TENNESSEE,
Tennessee Valley Authority, Knoxville.
For primary bibliographic entry see Field 02A.
W70-07081

KEENER V SHARP (MAINTAINING OF DAM IN NATURAL WATERCOURSE ENJOINED).

95 SW 2d 648-654 (Mo Ct App 1936).

Descriptors: *Watercourses (Legal), *Dams, *Missouri, *Surface waters, Standing waters, Sluices, Bayous, Lakes, Overflow, Impounded waters, Impoundments, Water levels, Watersheds (Basins), Mississippi River, Obstruction to flow, Overland flow, Rivers, Inflow, Runoff, Legal aspects, Water law, Judicial decisions, Remedies, Riddance (Legal aspects), Repulsion (Legal aspects).
Identifiers: *'Common enemy' rule, Continuing trespass.

Plaintiffs owned land between Morris Lake and the Mississippi River. The lake was connected with the river by a natural drain and watercourse, through which waters of the river flowed into the lake when the river rose, and flowed back into the river when the river fell. Defendants erected a sluice or dam in the drain, obstructed flow there through and caused water to stand on plaintiffs' land. Plaintiffs sought to enjoin defendants from maintaining and operating the dam. Defendants alleged that the water in the lake, as well as the overflow therefrom, was surface water, against which a landowner has the right to fight and change conditions without being liable to adjoining landowners. The court held that surface water is separated from waters in a natural body, such as a lake or river. A natural drain with well-defined banks, which is the outlet of a lake, is a natural watercourse and may be regarded as part of the lake. The overflow from the lake which was being retained by defendants was part of the lake and was not surface water. The court enjoined the maintenance of the defendants' dam as a continuing trespass. (Cuevas-Florida)
W70-07110

LOUISVILLE AND N R CO V LASWELL (INTERFERENCE WITH THE NATURAL FLOW OF WATER ONTO ADJOINING LAND).

187 SW 2d 732-736 (Ky 1945).

Descriptors: *Kentucky, *Natural flow doctrine, *Riparian rights, *Railroads, Boundaries (Property), Easements, Relative rights, Riparian land, Culverts, Right-of-way, Legal aspects, Alteration of flow, Obstruction to flow, Flood damage, Damages, Overflow, Judicial decisions, Remedies, Rainfall, Landfill.

Defendant railroad company which owned a right-of-way running parallel to a creek which bounded plaintiff's property on the west, constructed a double tract over a high fill, through which it built a culvert to carry water from the high land into the creek. The owner of a strip of land between the right-of-way and the creek built a fence which extended onto defendant's land with defendant's knowledge. Plaintiff contended that the culvert was a nuisance in that it restricted the natural flow of water such that, in heavy rainfall, the water was forced rapidly through the culvert, creating a new water passage over plaintiff's land and causing overflow thereonto. Plaintiff further contended that the culvert was a temporary structure, thus not within the 5 year statute of limitation on suits for damages caused by permanent structure, and that defendant was also liable for damages caused by the fence built on its property with its knowledge. The court held that a structure which can be easily improved or changed at reasonable expense is temporary. In this case the culvert was clearly a permanent structure and the statute of limitation applied. The fence was clearly a temporary structure under the statute of limitation. (Clarke-Florida)
W70-07112

RIGGS V KETNER (PRESCRIPTIVE RIGHT TO ARTIFICIAL INCREASES IN WATER FLOW ONTO ADJOINING LANDS).
187 SW 2d 287-289 (Ky 1945).

Descriptors: *Kentucky, *Prescriptive rights, *Drainage water, *Pipelines, Boundaries (Property), Judicial decisions, Legal aspects, Natural flow doctrine, Overlying proprietor, Land tenure, Relative rights, Riddance (Legal aspects), Surface water, Surface runoff, Overdraft, Pipes, Drains, Drainage systems, Sewers.

Plaintiff and defendant acquired their land from a common tract, the owner of which laid a drainage pipe from plaintiff's higher land under defendant's lower land into a public sewer. Neither party knew of the existence of the pipe until the portion under defendant's land broke, causing defendant's land to be flooded. Defendant then plugged the pipe, preventing water from plaintiff's land from draining. Plaintiff sued to enjoin defendant from maintaining the plug. The court held that despite the fact that neither party knew of the pipe's existence, a prescriptive right to the use thereof became effective no later than 15 years after defendant's vendor purchased the lower tract from the original owner. Although the pipe increased the flow of water from the upper to the lower tract, the prescriptive right to such increase ripened when the statutory period, running from the date of original sale of the lower tract, expired. (Clarke-Florida)
W70-07113

CHESAPEAKE AND O RY V CARMICHAEL (RAILROAD'S NEGLIGENCE IN MAINTAINING DRAINAGE DITCH ALLEGED TO HAVE CAUSED FLOOD DAMAGE).
184 SW 2d 91-93 (Ky 1944).

Descriptors: *Kentucky, *Flood damage, *Railroads, *Drainage systems, Floodwaters, Right-of-way, Ditches, Streams, Floods, Drainage, Remedies, Judicial decisions, Legal aspects, Open channels, Flood control, Overflow, Damages.

The plaintiff alleged that the railroads' failure to properly maintain a drainage ditch, along their right-of-way permitted floodwaters to overflow plaintiff's land, causing damage. The court held that it was not necessary in order to introduce evidence thereto as argued by plaintiff, for the defendant to specially plead that the flood was an act of God and not due to negligence of defendant. A general denial of negligence was sufficient to serve as a base for the introduction of evidence affirmatively showing that the flood damage was caused by something other than defendant's negligence. The court held that the evidence clearly showed that defendant's negligence was not responsible for the flood damage. Due to the extraordinary magnitude

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of the flood, damage would have occurred even if the defendant's ditch had been clear. A judgment below for the plaintiff was reversed. (Caldwell-Florida)
W70-07116

ST LOUIS-S F RY V SPRADLEY (FLOOD DAMAGE FROM WATER BACKED UP BY RAILROAD EMBANKMENT).

133 SW2d 5-9 (Ark 1939).

Descriptors: *Arkansas, *Obstruction to flow, *Railroads, *Flood damage, Legal aspects, Judicial decisions, Overflow, Flood water, Buildings, Drainage, Slopes, Embankments, Roadbanks, Barriers, Culverts, Property values, Runoff, Structures, Remedies, Depreciation, Damages.

Plaintiff claimed that defendant railroad had negligently constructed its roadbed thereby backing up floodwater onto plaintiff's property. Recovery was sought for flood damage to plaintiff's inventory and to the liquor store located on his property. Defendant argued that, as the construction was of a permanent nature, the three year statute of limitations under state law started to run when the obstruction was completed. As the object causing the flooding had been in existence longer than 3 years, plaintiff's recovery was barred. The court, however, held that plaintiff could not be charged with knowledge of permanent nature of the structure and the extent to which damage would result therefrom. The statute of limitations therefore did not begin to run until the floods actually occurred, and did not bar the claim. However, plaintiff was held not entitled to recovery for lost profits due to inventory damage, and the court found that damages to the store must be reduced by depreciation of the building and by the fact that it had been flooded several times before. (Caldwell-Florida)
W70-07119

WESTERN UNION TEL CO V BYRD (FLOOD DAMAGE RESULTING FROM WEAKENING OF LEVEE AS A RESULT OF THE INSTALLATION OF A POLE ON IT).

122 SW2d 569-580 (Ark 1939).

Descriptors: *Arkansas, *Levees, *Water levels, *Blowouts, Flood damage, Crops, Land tenure, Overflow, Floodwaters, Bayous, Storm Runoff, Damages, Remedies, Flood control, Flood protection, Gravity, Surveys, Elevation, Topography, Measurement, Floods, Legal aspects, Judicial decisions.

Plaintiffs alleged that the defendant company had negligently placed a telegraph pole on the crown of a bayou levee, causing the levee to rupture and flood plaintiffs' farmlands. Defendant claimed there was no negligence in the installation of the pole, and contended that, in any event, the bayou overflowed the entire levee at its highest point. This being so, defendant argued, even if its negligence caused the levee blowout, it was not the proximate cause of the flood damage, as the lands would have been flooded anyway. In support of its contention, defendant adduced elevation measurements from several flooded locations to prove the water level was higher than the highest point of the levee. Plaintiffs introduced much testimony to the effect that all the floodwaters came through the hole in the levee caused by the pole, and that the water level was at all times lower than the top of the levee. The court held that while laws of nature (water seeking its own level) controlled over conflicting oral testimony, the jury was entitled to weigh the conflicting testimony establishing the water levels in the same manner as other evidence. Therefore, a jury verdict for plaintiffs was affirmed. (Caldwell-Florida)
W70-07120

EVANS V MASSMAN CONST CO (LIABILITY OF GOVERNMENT AGENT FOR NEGLECTFUL FLOODING OF RIPARIAN LAND).

115 SW2d 163-170 (Mo Ct App 1938).

Descriptors: *Missouri, *Dikes, *Federal government, *Contracts, Riparian land, Flood damage, Riparian rights, Federal jurisdiction, Condemnation, Judicial decisions, Legal aspects, Navigation, Navigable rivers, Flood control, Alteration of flow, Obstruction of flow, Levees, Check structures, Eminent domain, Remedies, Damages.
Identifiers: *Government contracts.

Defendant contractor, pursuant to a government contract for the purpose of improving navigation, built a dike partially across the Missouri River. Evidence tended to show and the trial jury found that the dike did not meet certain specifications of the contract and a War Department standing order. Unauthorized mats increased the total obstruction and retarded water flow. Moreover, the dike was constructed too close to the opposite shore. Evidence indicated that the water pressures created by the dike caused the bursting of plaintiff's levee and widespread flooding of his land. The contract stated that the federal government would not be liable for damages caused by defendant contractor in the construction of the dike. The court indicated that where improvement of navigation by an agent of the government necessarily results in damages to riparian owners, such owners may not recover from the government unless the damage is great enough to constitute a confiscation of property. Where the damage is only consequential, such damage is tortious at best, and the government is immune from suit in tort. The government agent, however, may be liable personally for such damages if he acts beyond the authority of the contract or if he acts negligently. The evidence supported a finding that plaintiff acted outside the authority of the contract and in so doing was negligent. (Clarke-Florida)
W70-07122

KEENER V SHARP (REPULSION OF SURFACE WATERS).

111 SW2d 118-121 (Mo 1937).

Descriptors: *Missouri, *Repulsion (Legal aspects), *Bayous, *Surface waters, Boundaries (Property), Riparian rights, Drainage, Judicial decisions, Legal aspects, Natural flow doctrine, Relative rights, Riparian land, Usufructuary right, Surface runoff, Drainage water, Floods, Streamflow, Watercourses (Legal), Natural streams, Dams.
Identifiers: *Water gates.

Defendant built a water gate in a bayou for the purpose of raising the water level in an adjoining lake and thereby floating timber through the lake, the bayou and ultimately into the Mississippi River. Operation of the water gate caused the water to rise on plaintiff's land from 22 inches to 4 feet. Plaintiff sought to enjoin the operation of the water gate on the ground that the bayou was a well-defined watercourse, and defendant had no right to obstruct the flow of water through it. Defendant claimed such a right under the common enemy rule on the grounds that water in the bayou was merely surface water. The court stated that Missouri followed the common enemy rule, and that a person may ward surface water off his land onto the land of his neighbor providing he does not unnecessarily collect it and then discharge it. Also, a natural watercourse cannot be dammed and its waters diverted onto another's land causing damage to that land without compensation therefor. The court defined 'watercourse' as a natural body of water having a definite channel for the conveyance of water and through which water usually flows, though not necessarily continually. Relying on this definition, the court found the bayou to be a natural watercourse, and plaintiff's plea for an injunction was granted. (Clarke-Florida)
W70-07123

RUEHS V SCHANTZ (RIGHT OF UPHILL OWNER TO INCREASE DISCHARGE OF GROUNDWATER ONTO DOWNHILL PROPERTY).

TY BY USE OF TILE DRAINS).

15 NW2d 148-150 (Mich 1944).

Descriptors: *Michigan, *Tile drains, *Riddance (Legal aspects), *Natural flow, Saturated flow, Discharge (Water), Relative rights, Prescriptive rights, Groundwater, Groundwater management, Reasonable use, Land tenure, Water rights, Judicial decisions, Legal aspects, Remedies, Drainage systems, Soil water movement, Water table, Percolation, Subsurface drainage, Damages, Drainage effects, Drainage systems.

Defendant, an uphill landowner, proposed to construct tile drains on his property. Such drains would have concededly had the effect of increasing the flow of water onto plaintiffs' down hill land. There was some natural flow of surface water from defendants' to plaintiffs' land, and plaintiffs did not challenge defendants' right to have this flow continue. However, plaintiffs claimed that any addition to this natural flow by a tile drainage system constituted a trespass. The court found that the effect of the drainage system would be to enable defendant to use more of his land while making more of plaintiffs' land unusable because of excess water. The court held that defendant had no right to do this and that plaintiff was entitled to an injunction against the installation of the tile drains. Defendant had the right to drain his land, but he did not have the right to do so by casting an increased flow of water on downhill property to the injury thereof. (Caldwell-Florida)
W70-07131

DRAINAGE, SOIL, CONSERVATION, ETC (WATERSHED IMPROVEMENT DISTRICTS).

Va Code Ann secs 21-112.1 thru 21-112.21 (1960), as amended, (Supp 1968).

Descriptors: *Virginia, *Drainage systems, *Watershed management, *Erosion control, Flood control, Land management, Legislation, Administration, Regulation, Conservation, Erosion, Soil conservation, Water control, Drainage districts, State governments, Local governments, Legal aspects, Taxes, Assessments, Financing, Financial feasibility, Interest, Eminent domain, Easements.

A watershed improvement district may be established within a soil and water conservation district to help prevent soil erosion. A majority of landowners within the limits of a proposed watershed improvement district may petition for such establishment. Notice and hearing concerning the need for such a district shall be held, and if a need is determined, the boundaries of such district will be defined. A referendum as to the feasibility of such district will be presented to the landowners therein, and a 2/3 vote is required for the district's creation. Administrative procedures for the creation and operation of the district are outlined. Such district is considered a governmental subdivision of the state and has the power to tax for revenue to operate the district. The district's governing body may incur indebtedness by the issuance of bonds upon a poll of the landowners. An annual tax may be levied to retire the interest on such indebtedness. The district shall have the powers of eminent domain. (Barnett-Florida)
W70-07132

LEVEE DISTRICTS ORGANIZED BY COUNTY COURT.

Mo Ann Stat secs 245.285-245.330 (1959).

Descriptors: *Missouri, *Levees, *Flood control, *Drainage systems, Dikes, Check structures, Flood protection, Multiple-purpose projects, Embankments, Retaining walls, Legislation, Local governments, State governments, Federal government, Navigable streams, Overflow, Flood plains, Drainage districts, Reclamation.
Identifiers: *Levee districts.

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The term 'levee districts' shall be construed to include all districts organized for the purpose of establishing levees, dikes or reclamation improvements adjacent to any body of swamp, wet or overflowed land. County courts are empowered to divide the county into one or more districts having corporate powers. Consent of the federal government shall be obtained before undertaking improvements upon navigable streams. Proper notice shall be given of application for the establishment of a district. The board of directors may bring to the attention of the county court lands subject to overflow which are not included in a district and request their inclusion in a proper district. Levee districts may be enlarged upon approval of landowners within the district and those who are sought to be included in the enlarged district. Any levee district now existing can reorganize under the provisions of this act. (Hubener-Florida)
W70-07133

SHELL V TOWN OF EVARTS (DAM FAILURE AND IMPOUNDED WATERS).

178 SW2d 32-36 (Ky 1944)

Descriptors: *Kentucky, *Reservoirs, *Impounded waters, *Earth dams, Mine water, Dams, Judicial decisions, Legal aspects, Discharge (Water), Reservoir construction, Reservoir design, Flood damage, Water control, Flood water, Mining, Dam construction, Dam failure, Earthworks, Impoundments, Retaining walls, Washouts.

Owners of a mine licensed the defendant town to maintain and operate an improvised mine reservoir located at the top of a hill. In connection with its operation, defendant constructed a dam or retaining wall at the mouth drift of the mine in order to impound the large volume of accumulated water. Within a few months following its construction, the dam suddenly broke and the impounded lake water overflowed and damaged plaintiff's property situated in the town directly below the reservoir. Plaintiff alleged and presented testimony, in his action to recover, that the dam was negligently constructed of mud, sticks, and other improper substances, rendering it defective to restrain the accumulated water. The Kentucky Court of Appeals held that where evidence indicated that plaintiff's injury was the natural and foreseeable result of the dam's negligent construction, a directed verdict for defendant was improper. The court stated that the liability of one constructing a reservoir on his premises, which bursts, rests on the ground of negligence in constructing or maintaining the reservoir. Furthermore, where the mine owners licensed the town to maintain a dangerous reservoir on its property, the owners also become liable. (Powell-Florida)
W70-07135

INMON V CHESAPEAKE AND O RY (WATER DAMAGE FROM CULVERT DISCHARGE).
158 SW2d 147-149 (Ky 1942).

Descriptors: *Kentucky, *Culverts, *Drainage systems, *Flood damage, Discharge (Water), Judicial decisions, Legal aspects, Surface runoff, Drains, Ditches, Surface drainage, Railroads, Streams, Drainage water, Drainage effects, Conveyance structures, Highways, State governments, Land tenure, Mountains.

Plaintiff's property consisted of five dwelling houses which fronted on the south side of defendant's railroad tracks. On the north side of the tracks was a mountainside with a highway in between. Surface water flowed from the mountainside, beneath the highway, into a drain, then through a culvert under the tracks at a point opposite plaintiff's property. This culvert was connected to a wooden box drain beneath the passway separating the tracks from plaintiff's property. Water passing through the culvert and box drain was conveyed through an open ditch to a creek behind plaintiff's property. Flooding, which damaged plaintiff's property resulted

when refuse filled the open ditch. Plaintiff's action for damages resulted in an adverse judgment which was affirmed. The Kentucky Court of Appeals held that where the culvert under defendant's tracks was but a single link in a drainage system constructed jointly by the state, the railroad and the plaintiff's predecessor in title who had treated the system as a permanent one, neither the parties nor the successors in title could assert that the structure was improperly constructed so as to render the defendant liable for damage caused by water discharged by the culvert. (Powell-Florida)
W70-07136

4B. Groundwater Management**RECORDS OF OBSERVATION WELLS AND WATER-LEVEL FLUCTUATIONS IN THE ABERDEEN-SPRINGFIELD AREA, BINGHAM AND POWER COUNTIES, IDAHO, IN 1968**

Geological Survey, Boise, Idaho.
H. G. Sisco.
Geological Survey mimeo report, 1970. 43 p, 17 fig, 1 tab, 15 ref.

Descriptors: *Observation wells, *Water level fluctuations, *Idaho, Water levels, Groundwater, Aquifers, Irrigation water, Hydrographs, Data collections, Hydrologic data.

Identifiers: Bingham County (Idaho), Power County (Idaho).

Records of water-level fluctuations in observation wells in the Aberdeen-Springfield area, Bingham and Power Counties, Idaho are tabulated. The main observation-well network consists of 20 wells located west of the Snake River and east of the Aberdeen and High Line Canals in an area irrigated with water from the Aberdeen Canal system. Four wells located south of the American Falls Reservoir between the City of American Falls and the Portneuf River are in an area irrigated by surface water and groundwater. Eight wells located west of the High Line and Aberdeen Canals are in areas irrigated only by groundwater pumping. The well near Ferry Butte is in an area of natural recharge in the Fort Hall Bottoms. Periodic depth-to-water measurements were made in 28 wells at approximately monthly intervals. In addition, recording gages were operated on 2 wells in Bingham County and on 3 wells in Power County. (Knapp-USGS)
W70-06732

HYDROGEOLOGICAL RECONNAISSANCE OF THE NORTH NASHWAKSIS BASIN, NEW BRUNSWICK,

Department of Energy, Mines and Resources, Ottawa (Ontario), Inland Waters Branch.
For primary bibliographic entry see Field 02F.
W70-06765

COARSE MEDIA FILTRATION FOR ARTIFICIAL RECHARGE.

Illinois State Water Survey, Urbana; and Tennessee Valley Authority, Chattanooga.
Robert H. Harmeson, Roger L. Thomas, and Ralph L. Evans.
Journal American Water Works Association, Vol 60, No 12, p 1396-1403, December 1968. 8 p, 4 fig, 4 tab.

Descriptors: *Artificial recharge, *Pit recharge, *Filtration, *Filters, Sands, Porous media, Infiltration, Particle size, Water quality, Water pollution sources, Water yield, Correlation analysis, Regression analysis, On-site tests, Laboratory tests.
Identifiers: Recharge water filtration.

When groundwater conditions in Peoria were approaching a critical state, study was made of various schemes for artificial recharge used in this country and abroad. Preliminary tests of the effects of artificially recharging the glacial drift aquifer were conducted in 1941 in an abandoned gravel pit near the banks of the Illinois River. Groundwater

levels in the aquifer responded both rapidly and substantially. Because bacterial degradation of groundwater quality occurred in one of 4 observation wells during these preliminary tests, it was assumed that a sand filtration layer, based on water treatment practice, would be required in recharge pits to protect the groundwater from bacterial contamination. Multiple correlations and regression analysis of data provide an equation relating the variables studied. This equation can be used to indicate the filtration efficiency of coarse media with relation to the parameters of filter layer depth, coarse media diameter, and rate of recharge or to indicate the concentration of suspended solids transmitted through coarse media during artificial recharge, base on influent suspended solids concentration, rate of recharge, filter layer depth, and coarse media diameter. (Knapp-USGS)
W70-06793

ARTIFICIAL RECHARGE IN WATER RESOURCES MANAGEMENT,

Texas Tech Univ., Lubbock. Dept. of Agricultural Engineering; and Texas Tech Univ., Lubbock. International Center for Arid and Semi-Arid Land Studies.

Marvin J. Dvoracek, and Sam H. Peterson.
American Society of Civil Engineers, National Water Resources Engineering Meeting, Memphis, Tennessee, January 26-30 1970, Preprint 1111. 27 p, 8 fig, 16 ref.

Descriptors: *Artificial recharge, *Groundwater recharge, *Water resources, *Water conservation, *Water supply, Water management (Applied), Natural resources, Arid lands, Semiarid climates, Southwestern U.S., Texas, Induced infiltration, Water spreading, Trenches, Pit recharge, Natural recharge, Groundwater, Irrigation water, Sediments.

Identifiers: Ogallala formation, Irrigated agriculture, Recharge wells, Recharge shafts, Rubble cones.

Water resources for arid and semiarid regions of the United States are only marginal at the present time and new sources of water are no longer available. Artificial recharge techniques are presented as one method of partially alleviating the problem. Artificial recharge is presented in the context of the water depletion of the Ogallala formation on the High Plains of Texas. There, as in the United States as a whole, irrigated agriculture is the major water user. Several recharge mechanisms are discussed, such as recharge wells, shafts, holes, pits, trenches, rubble cones, and water spreading. All of the methods share the problem of sediment content in water used for recharge, but the problem is not insurmountable. In some cases economic value of artificially recharged water has already outweighed the limitations. (Carr-Arizona)
W70-06831

SYCAMORE COAL CO V STANLEY (DESTRUCTION OF WELL BY NEARBY DRILLING).

166 AW2d 293-294 (Ky 1942).

Descriptors: *Kentucky, *Subsurface waters, *Subsurface investigations, *Relative rights, Underground streams, Land use, Land tenure, Percolation, Groundwater, Groundwater movement, Streams, Surface-groundwater relationships, Wells, Water utilization, Reasonable use, Springs, Damages, Legal aspects, Drilling, Judicial decisions, Exploitation, Coals, Coal mines.

Defendant drilled a hole on his property to determine if an underlying coal seam existed, whereupon plaintiff's well dried up. The plaintiff claimed that defendant had destroyed the underground stream of water leading to their well. The court found no evidence of a subterranean stream, stating that in any event a landowner making legitimate use of his property is not liable to the owners of adjoining lands for injuries to wells or springs fed by

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hidden underground streams flowing in unknown channels. A distinction was drawn between underground streams flowing in a defined channel, which are governed by the rules pertaining to surface streams, and groundwater, which belongs to the owner of the soil in which it is found. The landowner was held to have the right to make reasonable use of the groundwater percolating beneath his property. As no malice or unreasonableness was found, defendant was held not liable. (Caldwell-Florida)
W70-06838

REPORT ON REQUIRED FACILITIES FOR REPLENISHING AND PROTECTING GROUND-WATER RESERVES IN THE CENTRAL AND WEST COAST GROUNDWATER BASINS, PART III: DOMINGUEZ GAP BARRIER PROJECT, Los Angeles County Flood Control District, Calif. Clinton Milne, and David R. Carrier.

May 1966. 53 p, 9 fig, 2 tab, 14 ref.

Descriptors: *Recharge, *Artificial recharge, *Groundwater recharge, *Induced recharge, *Aquifers, *Recharge wells, *Saline water intrusion, *Barriers.

Identifiers: *Los Angeles County Flood Control District, *Dominquez Gap Barrier Project.

This is the final report of a three-part investigation to determine a comprehensive corrective program of groundwater replenishment and protection for the Central and West Coast Basins. It presents the results of the studies for the prevention of seawater intrusion from San Pedro Bay into the West Coast Basin through the Dominquez Gap area. For many years, the production of groundwater for domestic and industrial use from the West Coast Basin has exceeded the natural replenishment. This over-production has lowered the basin's water level to below sea level, causing an inland groundwater gradient from the ocean. This has caused seawater intrusion, in the Dominquez Gap area, into aquifers that are exposed to saline water. Detailed geologic and hydrologic studies were conducted within the area to determine the location, rate of movement, and route of seawater intrusion to provide a basis for the design of barrier facilities to prevent this intrusion. A recharge line is recommended along the area of hydraulic emergence between the Gaspar zone and the 200-foot sand aquifer to prevent the already intruded seawater from moving into the 200-foot sand zone. It was recommended that the \$3,916,000 project begin in fiscal year 1966-67 and be completed in 1969. (Poertner-Chicago)

W70-06917

RECHARGE OF GROUNDWATER FROM RENOVATED SEWAGE EFFLUENT BY SPRAY IRRIGATION,

Pennsylvania State Univ., University Park. Dept. of Geology and Geophysics.

Richard R. Parizek, and Earl A. Myers.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p426-443, 5 fig, 1 tab, 11 ref.

Descriptors: *Groundwater recharge, *Sewage effluents, *Nutrients, *Water quality, *Irrigation, Agronomic crops, Forest soils, Evapotranspiration, Surface waters, Drainage, Infiltration.

Identifiers: *Reuse, *Return, *Renovation.

Because there are potential problems encountered in discharging sewage treatment plant effluent into a natural water course, namely increased plant growth unfavorable to fish and groundwater depletion, attention should be directed toward alternatives. It is suggested here that the alternatives should include the basic principles embodied in the renovation-conservation cycle. Four aspects of this cycle are considered: Return, Renovation, Recharge, and Reuse. In order to achieve high quality groundwater recharge, adequate treatment must be insured. This requires the uniform distribution of an appropriate rate per hour and amount

per week of effluent return to a non-deteriorating, efficient renovation zone. Sprinkler irrigation on field crops and forested areas was found to be most successful with rates of 1/4 inch per hour, most frequently amounting to 2 inches per week. This was satisfactory even at -12 deg F. It was found that renovation was possible with biologically, physically, and chemically active surface soil and agronomic forest crops doing an excellent job of removing and assimilating effluent nutrients. Winter irrigation requires that nutrients not be added faster nor in greater amounts than can be adsorbed and retained within the upper soil profile for summer use. Under the ideal conditions detailed, 85-90 per cent of the effluent returned can be recharged. However, not all areas will permit significant recharge. To make room for recharge and to insure renovation, one must frequently consider groundwater reuse. Several means of reuse are discussed. (Preckwinkle-Chicago)

W70-06953

UNCONFINED AQUIFER SEEPAGE BY CAPILARY FLOW THEORY,

Cornell Univ., Ithaca, N.Y.

For primary bibliographic entry see Field 02F.

W70-06978

WATER RESOURCES OF IOWA.

Iowa State Geological Survey, Iowa City.

For primary bibliographic entry see Field 06B.

W70-06981

GROUNDWATER RESOURCES OF IOWA,

Geological Survey, Iowa City, Iowa; and Iowa State Geological Survey, Iowa City.

For primary bibliographic entry see Field 02F.

W70-06984

MANAGEMENT OF IOWA'S WATER RESOURCES,

Office of Water Resources Research, Washington, D.C.

For primary bibliographic entry see Field 06B.

W70-06988

A MEAN VALUE THEOREM IN PORE PRESSURE EVALUATION BY THE METHOD OF IMAGES,

McGill Univ., Montreal (Quebec).

G. D. Ransford.

Water Resources Research, Vol 6, No 2, p 645-648, April 1970. 4 p, 2 ref.

Descriptors: *Groundwater movement, *Pore pressure, Equations, Drainage, Permeability, Laplaces equation, Porous media.

Identifiers: Method of images.

It is shown that mean pore pressure measured transversally through a rectangular domain in which groundwater flow is taking place from front to rear varies linearly from one sink (or source) to another provided such sinks or sources are located on the centerline of the domain, midway between the side faces. Methods of computation of the mean pore pressure at any section are given. The specific application is to uplift evaluation in concrete dams, but the theorem applies to any problem governed by the Laplace theorem. (Knapp-USGS)

W70-07009

REGULATING GROUNDWATER IN HUMID ZONES,

Earl F. Murphy.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 55-71, 1970. 17 p, 57 ref.

Descriptors: *Subsurface waters, *Groundwater, *Water management (Applied), *Water districts, Aquifers, Surface-groundwater relationships,

Regulation, Fresh water, Saline water, Saline water intrusion, Potable water, Programs, Water control, Control systems, Water conservation, Drainage water, Environmental sanitation, Water quality control, Non-structural alternatives, Economics, Administration, Water resources development, Humid areas, Humid climates, Hydrologic cycle.

The history and development of groundwater regulation are discussed. A number of problems in groundwater regulation are discussed, including: (1) the invasion of fresh water aquifers by salt water that threatens a total loss of potable water supplies; (2) the excessive demands on underground sources of water; (3) the fragmentary water management programs; and (4) the degree of constitutional protection afforded rights in groundwater as property interests under the fifth amendment. The creation of a legal system for groundwater in humid zones responsive to a totally industrialized and urbanized environment is needed for the exploitation of groundwater. Greater consolidation must be achieved in water extraction if an adequate regulatory scheme is to be developed. Enabling acts establishing groundwater districts of a size determined by the character and location of major aquifers should be passed. All interests in groundwater within the district should be conveyed by the landowners to the district so that the costs of groundwater use can be minimized and the benefits maximized. Water districts reduce desiccation of underground water sources, conserve drainage water, and provide information about subsurface hydrology. (See also W70-07095). (Powell-Florida)

W70-07099

FELDHAUS V JEFFERSON COUNTY (DIFFERENCE BETWEEN PERCOLATING WATER AND UNDERGROUND STREAM).

95 SW2d 790-792 (Ky 1936).

Descriptors: *Kentucky, *Springs, *Subsurface waters, *Underground streams, Drainage, Local governments, Spring waters, Water supply, Damages, Legal aspects, Water sources, Drainage systems, Groundwater, Groundwater basins, Surface-groundwater relationships, Percolation, Percolating water, Subsurface drainage, Ditches, Deep percolation, Judicial decisions, Relative rights, Obstruction to flow, Alteration of flow.

The plaintiff claimed that defendant county, in constructing a drainage ditch, had cut an underground stream which fed a spring on her property causing the spring to dry up. The court drew a distinction between underground percolating water, in which the owner of the land above has an absolute right of use and appropriation, and underground streams. Because of the nature of the terrain any underground stream necessarily had to be very deep, and the court found no evidence that the county's drainage ditch had been cut deep enough to interfere with the flow of any possible stream. A judgment for the defendant county was affirmed. (Caldwell-Florida)

W70-07109

4C. Effects on Water of Man's Non-Water Activities

AN ECOLOGICAL STUDY OF THE TWIN CITIES METROPOLITAN AREA,

Metropolitan Council of the Twin Cities, Minn.

For primary bibliographic entry see Field 06G.

W70-06764

NUTRIENT LOSS ACCELERATED BY CLEAR-CUTTING OF A FOREST ECOSYSTEM,

Yale Univ., New Haven, Conn.; Dartmouth Coll., Hanover, N. H.; Geological Survey, Washington, D. C.; and Forest Service (USDA), Durham, N. H.

F. H. Bormann, G. E. Likens, D. W. Fisher, and R. S. Pierce.

Identification of Pollutants—Group 5A

Science, Vol 159, p 882-884, February 23, 1968. 3 p, 1 fig, 1 tab, 14 ref. NSF Grants GB 1144, GB 4169, GB 6757, and GB 6742.

Descriptors: *Clear-cutting, *Leaching, *Nutrients, *Soil-water-plant relationships, Small watersheds, Nitrates, Runoff, Vegetation effects, Nitrification, Ecology, Eutrophication, Water pollution sources.

Identifiers: Nutrient losses.

The forest of a small watershed-ecosystem was cut in order to determine the effects of removal of vegetation on nutrient cycles. Relative to undisturbed ecosystem, the cut ecosystem exhibited accelerated loss of nutrients: nitrogen lost during the first year after cutting was equivalent to the amount annually turned over in an undisturbed system, and losses of cations were 3 to 20 times greater than from comparable undisturbed systems. Possible causes of the pattern of nutrient loss from the cut ecosystem are discussed. (Knapp-USGS) W70-06796

INCREASED PRECIPITATION FROM URBAN-INDUSTRIAL EFFECTS,

Illinois State Water Survey, Peoria.

Stanley A. Changnon, Jr.

Paper presented at the Annual and Environmental Meeting of the American Society of Civil Engineers, Chicago, October 13-17, 1969; Preprint 1015. 14 p, 1 fig, 1 tab.

Descriptors: *Precipitation, *Thunderstorms, *Weather, *Weather patterns, *Rainfall disposition, *Distribution patterns, *Rain gages, *Rainfall, *Storms, *Weather modification, *Urbanization, *Meteorological data, *Weather data, Winds, Snowfall, Storm structure, Orography, Industrial wastes, Industrial plants, Cities, Convection, Atmosphere, Hail, Cloud seeding.

Identifiers: *Urban effects, *Industrial effects.

The increases in urban-produced precipitation of four various sized midwest cities and two large eastern cities are discussed. Climatic studies have shown apparent urban produced precipitation increases ranging from 5 to 16 percent in annual precipitation and rain days, with 7 to 22 percent increases in summer thunderstorm days. Within the past 25 years, in an area downwind of Chicago, increases in precipitation have shown substantially greater increases, 31 to 246 percent. Little research has been done on this topic due to the sparsity of precipitation stations and inadequate instrumentation. Recent developments of airborne nuclei measuring instruments have led to isolated studies of condensation and freezing nuclei over several urban areas. In the midwest (highly industrialized Chicago, St. Louis, and the much smaller Champaign-Urbana, Illinois) studies showed a distinct maximum centered in or to the east of the cities. This supports the theory of urban produced increases on the prevailing eastward moving precipitation systems. Similar increases in precipitation were noted for Tulsa, Washington, D.C., New York and much greater increases in La Porte, Ind. (Poertner-Chicago) W70-06918

COASTAL ENGINEERING ASPECTS OF AN AIRPORT IN LAKE MICHIGAN,

Department of Public Works, Chicago, Ill.

For primary bibliographic entry see Field 08D.

W70-06921

INCREASES IN WATER YIELD FOLLOWING CLEAR-CUT LOGGING IN THE PACIFIC NORTHWEST,

US Forest Service (USDA), Corvallis, Oregon. Pacific Northwest Forest and Range Experimental Station.

For primary bibliographic entry see Field 03B.

W70-07007

OHIO SURFACE WATER RIGHTS,

For primary bibliographic entry see Field 06E.

W70-07063

RESEARCH NEEDS REGARDING SEDIMENT AND URBANIZATION,
Geological Survey, Fort Collins, Colo. Water Resources Div.
For primary bibliographic entry see Field 02J.
W70-07093

4D. Watershed Protection**BANK STABILIZATION IN SUSQUEHANNA RIVER BASIN,**

Corps of Engineers, Baltimore, Md. Basin Planning Branch.

James E. Crews.

ASCE Proceedings, Journal of the Waterways and Harbors Division, Vol 96, No WWI, Paper 7061, p 87-95, February 1970. 9 p, 12 fig, 2 tab, 8 ref.

Descriptors: *Bank erosion, *Stream erosion, *Bank stabilization, *Erosion control, *Pennsylvania, Stabilization, Riprap, Scour, Slope stabilization, Gabions.

Identifiers: *Susquehanna River basin.

Steambank erosion is a major problem in the Susquehanna River basin and results in continual losses or deterioration of productive lands through progressive scouring or natural channel relocations across oxbow bends. The major erosion problems within the basin occur above Sunbury, Pennsylvania, the confluence of the West Branch and main stem of the Susquehanna River. These problems include erosion to farm lands and erosion that causes structural damage to bridge abutments, retaining walls and buildings. The study of streambank stabilization within the Susquehanna River basin, was limited to the continuous type of protection such as riprap or a flexible, durable, relatively impermeable mattress. Riprap and gabions were found to be the most economical means of providing protection against caving streambanks. (Knapp-USGS)
W70-06733

EROSION AND RIPRAP REQUIREMENTS AT CULVERT AND STORM-DRAIN OUTLETS,
Army Engineer Waterways Experiment Station, Vicksburg, Miss.

For primary bibliographic entry see Field 08A.

W70-06753

ERODED SOILS OF THE LOWER SWANSEA VALLEY,

University Coll. of Swansea (Wales). Dept. of Geography.

For primary bibliographic entry see Field 02J.

W70-06772

BIOTIC REGULATION OF PARTICULATE AND SOLUTION LOSSES FROM A FOREST ECOSYSTEM,

Yale Univ., New Haven, Conn. School of Forestry; and Dartmouth Coll., Hanover, N.H. Dept. of Biological Science.

For primary bibliographic entry see Field 02J.

W70-06778

5. WATER QUALITY MANAGEMENT AND PROTECTION**5A. Identification of Pollutants****COLIPHAGES AS VIRUS INDICATORS IN WATER AND WASTEWATER,**
Technion - Israel Inst. of Tech., Haifa. Sanitary Engineering Lab.

Y. Kott, and N. Buras.

Federal Water Pollution Control Admin, and Technion Research and Development Foundation.

Ltd, Haifa, April 1970. 50 p, 2 fig, 9 photo, 17 tab, 32 ref. FWPCA Research Grant 16030 DQN.

Descriptors: *Bioindicators, *Coliforms, *Bacteriophage, *Enteric bacteria, *Viruses, Water pollution, Water pollution control, Aquatic microbiology, Pollutant identification.

Identifiers: Enteroviruses.

Studies were made of identification of *E. coli* by using specific bacteriophages, and of using bacteriophage concentrations to make quantitative estimates of coliforms and enteroviruses. The use of 73 newly isolated bacteriophages gave satisfactory results. The bacteriophage mixtures showed to yield 70-90 per cent lysis in *E. coli* strains isolated from water and wastewater samples. The application of concentrated *E. coli* bacteriophage to M-Endo or MmFC showed very good results. The proposed test for counting various coliforms is done by filtering the water sample simultaneously through two filters. In the first *E. coli*, *A. aerogenes* and other coliforms are counted, the other one is exposed to *E. coli* bacteriophage. Here the total bacterial count is equivalent to that of the first filter less the lysed *E. coli* bacteria. (Knapp-USGS)
W70-06738

BIOCHEMICAL OXYGEN DEMAND, DISSOLVED OXYGEN, SELECTED NUTRIENTS, AND PESTICIDE RECORDS OF TEXAS SURFACE WATERS, 1968,

Geological Survey, Austin, Tex.

Alton J. Dupuy, Douglas B. Manigold, and Jean A. Schulze.

Texas Water Development Board Report 108, February 1970. 37 p, 1 fig, 2 tab, 7 ref.

Descriptors: *Water pollution, *Monitoring, *Dissolved oxygen, *Pesticides, *Texas, Sampling, Data collections, Water quality, Water pollution effects, Nitrates, Biochemical oxygen demand, Nutrients, Phosphates, Water temperature, Surface waters.

Identifiers: Water quality monitoring.

Data-collection networks for BOD (biochemical oxygen demand), dissolved oxygen, and selected nutrients and for pesticides were established in 1968 to provide information on the quality of surface waters of the State. Data collected through September 1968 at 58 BOD and nutrient stations and at 26 pesticides stations in the network are given in tables. The data were collected principally at selected existing streamflow gaging stations throughout the State, most of which are sites where additional chemical quality data are collected on a continuous, daily, or periodic basis. (Knapp-USGS)
W70-06749

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR DETECTION OF WATER POLLUTION,
Georgia Univ., Athens. Dept. of Entomology.

Chester M. Himel.

Available from the Clearinghouse as PB-191 812, \$3.00 in paper copy, \$0.65 in microfiche. Georgia University Annual Report, June 1969-May 1970. 12 p, 1 fig. FWQA Project 16020 EAQ — 5/70.

Descriptors: *Water pollution, *Insecticides, *Fluorometry, *Analytical techniques, Tracers, Water analysis, Tagging, Dye releases, Enzymes, Monitoring, Spectroscopy, Pollutant identification.

Identifiers: Water pollution detection.

The application of fluorescent probe-enzyme systems to detection of water pollution by insecticides was studied to determine the scientific and practical feasibility of this new concept. Many suitable fluorescent probe molecules can be synthesized. In combination with serum cholinesterase enzyme, these fluorescent probe-enzyme systems give a significant spectroscopic response in the presence of insecticides. A total of 18 new candidate fluorescent probe molecules were synthesized. Of those tested, 4 are useful probe molecules. (Knapp-USGS)

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5A—Identification of Pollutants

W70-06754

CHEMICAL CONTAMINANTS FOUND IN SURFACE AND SUBSURFACE WATER AS RELATED TO SOIL AND CLIMATIC CONDITIONS,

Maine Univ., Orono.

Eliot Epstein, and Roland A. Struchtemeyer.

Available from the Clearinghouse as PB-191 811, \$3.00 in paper copy, \$0.65 in microfiche. Main University Water Resources Center Project Completion Report, August 1969. 28 p, 10 tab, append. OWRR Project No A-006-ME.

Descriptors: *Insecticides, *Pesticides, *Pesticide residues, *Soils, *Maine, Clays, Clay minerals, Organic matter, Adsorption, Path of pollutants, Runoff, Water pollution sources, Persistence, Soil contamination, Water quality, DDT, Endrin.

Identifiers: Endosulfan.

Runoff was collected from plots maintained under various cropping systems and analyzed for pesticides and various elements by electron capture gas chromatography, atomic absorption, and colorimetry. The concentration and amounts of endosulfan, endrin and DDT were lower in runoff from a rotation system of potatoes, sugarbeets and peas than from continuous potatoes. The amounts of insecticides in runoff were small compared to the amount applied. Less than 1% of the amounts applied were in water, while the concentrations of insecticides were considerably higher in the soil or sediment fraction of the runoff. Insecticides tend to concentrate in the 0.08-0.5 micron clay fraction. Intact Marshall soil retained more of each insecticide than Caribou soil, probably because of higher organic matter content in Marshall soil. In the clay fraction the retention was higher in the Caribou soil. (Knapp-USGS)

W70-06756

TRACE-ELEMENT CONTAMINATION OF PARKLANDS IN URBAN AREAS,

Edinburgh Univ. (Scotland). School of Agriculture.

D. Purves, and E. Jean Mackenzie.

Journal of Soil Science, Vol 20, No 2, p 288-290, September 1969. 3 p, 2 tab, 14 ref.

Descriptors: *Soil chemistry, *Trace elements, *Urbanization, *Air pollution effects, Path of pollutants, Copper, Boron, Soil chemical properties, Geochemistry, Air pollution.

Identifiers: Soil contamination, Edinburgh (Scotland).

There are so many possible sources of trace-element contamination in urban gardens that it is difficult to determine the relative contributions made by various kinds of human activity in urban areas. Since urban parklands are subject to much less direct interference than cultivated gardens, a study of the trace-element composition of soils and herbage from such areas and from permanent pastures in rural areas should give a more valid comparison between urban and rural soils in general. Twelve representative samples of soil from parklands within the Edinburgh City boundary and the same number of samples from permanent pastures in the surrounding rural areas in the Lothians were analyzed. Corresponding samples of herbage were taken by clipping at each site and analyzed with respect to the same elements. All sampling was done during the first two weeks of June. Soils in urban parklands are markedly contaminated with Cu, B, Pb, and Zn. Herbage from the same areas contains significantly higher levels of Pb and Zn than herbage from permanent pastures in rural areas. (Knapp-USGS)

W70-06770

SABINE RIVER AUTHORITY OF TEXAS, WATER QUALITY STUDY,

Forrest and Cotton, Inc., Dallas, Tex.

T. C. Forrest, and J. A. Cotton.

In: Proceedings, National Estuarine Pollution Study Public Meeting, Orange, Texas, October 10, 1968. 22 p, 7 fig.

Descriptors: *Water quality, *Texas, *Louisiana, *Estuaries, Water management (Applied), Saline water intrusion, Water chemistry, Water pollution sources, Water pollution effects, Dissolved oxygen, Hydrogen ion concentration, Water temperature, Chlorides.

Identifiers: Sabine River (Tex-La).

Data are presented on dissolved oxygen, pH, temperature, and chlorides in the Sabine River, Texas and Louisiana. Other parameters were excluded for various reasons. Dissolved oxygen concentrations were generally favorable, with lower values towards the mouth of the river. There has been some decline of oxygen with time. The pH ranges are generally satisfactory throughout the river. Chlorides have ranged quite high in the upper reaches, but this situation has improved and now seems under control. Near the mouth a salt wedge intrudes for some distance; its effect can be demonstrated by a graphical model. Overall water quality is good in the Sabine, but there are indications that it has declined slightly as the river receives more use. Pollution control and quality regulation should be part of the future management operation. (Knapp-USGS)

W70-06798

EH AND pH OF OILFIELD WATERS,

Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center.

For primary bibliographic entry see Field 02K.

W70-06804

RAPID DETERMINATION OF CADMIUM AND COPPER IN PLATING WASTES AND RIVER WATER BY ATOMIC ABSORPTION SPECTROSCOPY,

Missouri Univ., Kansas City. Dept. of Chemistry.

James L. Robinson, Russell G. Barnekow, Jr., and Peter F. Lott.

French and German summaries included. Atomic Absorption Newsletter, Vol 8, No 3, p 60-64, May-June 1969. 5 p, 3 fig, 5 tab, 28 ref. OWRR Project A-009-MO.

Descriptors: *Water analysis, *Trace elements, *Copper, *Spectroscopy, Industrial wastes, Analytical techniques, Chemical analysis, Laboratory tests.

Identifiers: Atomic absorption spectroscopy, Plating wastes.

A method for the extraction and concentration of cadmium and copper from plating wastes and river water is described. The metals are extracted with 2-mercapto-benzothiazole into n-butyl acetate. They are determined in the extract by atomic absorption spectroscopy using the method of standard additions. (Knapp-USGS)

W70-06806

PARATHION - USE OF BLOOD CONCENTRATION TO DIAGNOSE MORTALITY OF FISH,

Federal Water Pollution Control Administration, Cincinnati, Ohio.

Donald I. Mount, and Harvey W. Boyle.

Environmental Science and Technology, Vol. 3, No. 11, p 1183-1185, Nov 1969. 2 tab, 2 fig, 9 ref.

Descriptors: *Fishkill, *Pesticide toxicity, Organophosphorus pesticides, Bullheads, Bioassay, Gas chromatography, Animal metabolism, Persistence, Spectroscopy.

Identifiers: *Parathion, Ictalurus nebulosus, Blood analyses. Acute exposure.

The need for methods to diagnose the cause of fish-kills is discussed. These researchers propose the measurement of parathion blood concentrations to detect fishkills caused by acute exposures to parathion. Ictalurus nebulosus were exposed to

various concentrations of parathion (from .015 to 2.0 mg/l) dissolved in water for time periods of up to 30 days. Blood samples were taken and analyzed by hexane extraction after freeze-thawing and by trichloroacetic acid precipitation. Both methods gave comparable recoveries. The concentration of parathion in the blood and in the water is closely related and can be used to predict death due to acute toxicity. After a 30-day exposure, only those fish in 0.015 mg/l appeared normal. Those in 0.03 mg/l had tremors at times. The author's feel that the presence of unaltered parathion in cold-blooded vertebrates (fish) should be studied further to determine if there is a significant accumulation in such animals. (Sjolseth-Washington) W70-06832

GAS-LIQUID CHROMATOGRAPHIC TECHNIQUES FOR PETROCHEMICAL WASTE WATER,

Union Carbide Corp., South Charleston, W. Va.

William J. Sugar, and Richard A. Conway.

Journal of the Water Pollution Control Federation, Vol 40, No 9, p 1622-1631, Sept 1968. 8 fig, 4 tab, 10 ref.

Descriptors: *Water analysis, *Chromatography, *Industrial wastes, *Organics, Spectrometers, Columns, Waste treatment.

Identifiers: *Petrochemical, Carbowax 20M, Volatile acids.

This study was made to extend recently published gas-liquid chromatographic techniques for identifying and measuring organics occurring as complex mixtures. Direct aqueous injection was practiced over a range of 1-100 mg/l. For general utility in analyzing petrochemical waste organics a 10 ft, 1/8 in. CARBOWAX 20 M column was selected. ATERGITOLE E68 substrate coupled with mass spectrometric and infrared identification of eluted components were used for confirmative purposes. For trace organic acid analysis, both (1) on-column injection into a CARBOWAX 20M column acid washed with terephthalic acid and (2) use of carrier gas wetted with CuSO₄ . 5 (H₂O) were necessary to eliminate ghosting. These procedures give suitable sensitivity and resolution, linear responses, insignificant base line noise, little peak tailing, and minimum ghosting. (Hancock-Texas) W70-06867

THE VOLUMETRIC DETERMINATION OF SULFATE IN WASTE WATERS (IN RUSSIAN),

Yu. F. Lotoshnikov, and O. N. Kukisheva.

Khimicheskie Volokna, No 1, p 72, 1968.

Descriptors: *Analytical techniques, *Sulfates, Volumetric analysis, Water analysis, Textiles.

Identifiers: *Textile mill wastes.

Sulfate-ion in textile waste water was determined with a relative error of <2% by a rapid volumetric procedure. Five drops of 0.2% aqueous alizarin red was added to a waste water sample containing 0.1-1.15 g. of sulfate-ion, and the sample was acidified by addition of acetic acid. If an inorganic acid was present it was first neutralized with sodium hydroxide. Ethyl alcohol was added, and the sample was titrated with 0.1 barium chloride. The analysis took approx. 15 min. The presence of < or = 20.5 g. of zinc ion/l or > or = 100 mg. of ferric ion/l, or < or = 10 mg. of aluminum ion/l did not interfere. (Work-North Carolina State Univ) W70-06892

CONCENTRATION OF VIRUSES FROM SEWAGE AND EXCRETA ON INSOLUBLE POLYELECTROLYTES,

Baylor Univ., Houston, Tex. Coll. of Medicine.

Craig Wallis, Saul Grinstein, Joseph L. Melnick, and Joseph E. Fields.

Applied Microbiology, Vol 18, No 6, p 1007-1014, December 1969. 1 fig, 7 tab, 11 ref.

Descriptors: *Viruses, *Sewage, *Adsorption, *Methodology, Analytical techniques.

Sources of Pollution—Group 5B

Identifiers: *Excreta, *Polyelectrolytes, Concentration, Detection.

The soluble cross-linked copolymer of maleic anhydride is described. It is reported to adsorb purified viruses avidly and selectively concentrate virus from crude culture in the presence of organic materials with quantitative recovery of the virus by elution. The objective of this study is the detection of viruses in sewage and human excreta comparing different concentration methods. The insoluble polyelectrolyte method was found to be most advantageous for recovering viruses from natural waters since it could be used to treat very large volumes of fluid more efficiently and economically than other methods with which it is compared. Viruses, either added to sewage or naturally contained in sewage, were preferentially adsorbed to this polyelectrolyte at a pH of 5 to 6 and were eluted at pH 8 and 9. Methods of virus recovery compared in this study were: aluminum hydroxide, cellulose membrane and insoluble polyelectrolyte. (Hancuff-Texas) W70-06912

INNOVATION IN MEMBRANE FILTER TECHNIQUE AS APPLIED TO WATER BACTERIOLOGY,

Denver Board of Water Commissioners, Colo.
William R. Van Nattan.

Typescript, 1969. 7 p, 1 tab.

Descriptors: *Microbiology, *Bacteria, *Membranes, *Filters, *Membrane processes, *Sewage bacteria, *Water pollution sources, Coliforms, Cultures, Laboratory tests.

Identifiers: *Water bacteriology.

New techniques in microbiological analysis of water are described. In a three-year study using the Membrane Filter Technique, over 35,000 potable water samples were processed and analyzed. Samples coming into the laboratory at a rate of 40 to 80 per day required an efficient system of collection, analysis and record-keeping to handle the load. The Membrane Filter Technique can process a relatively large volume of water with the assurance that all significant bacteria will be retained on the surface of the membrane for analysis. The testing area is kept 'clean' by an air filtration system. All equipment and tools are sterilized. Three types of culture media are used for detection of pollution. M-Endo broth is used for detection of coliform bacteria. Fecal-coliform broth detects the presence of a more recent pollution than coliforms, Enterococcus agar is used to indicate fecal Streptococci (animal intestinal waste). One objection to the Membrane Filter for water analysis is that the filter becomes plugged when processing turbid waters containing sediments; a method has been developed to transfer the growth from the turbid membrane. (Poertner-Chicago) W70-06914

TRACE ELEMENTS AND THEIR ORIGIN IN A METROPOLITAN WASTE WATER EFFLUENT,

Clair G. Farnsworth.
Board of Water Commissioners, Denver, Colo.
1969. Typescript, 22 p, 1 fig, 6 tab, 7 ref.

Descriptors: *Trace elements, *Domestic water, *Water chemistry, *Water quality, *Water reuse, *Elements, *Water sources, *Waste water treatment, Laboratory tests.

Identifiers: *Denver.

This study was undertaken to determine what effects domestic use has on concentrations of trace elements found in a water system such as in Metro-Denver. The elements considered were: arsenic, barium, bromine, chromium, columbium, copper, iron, lead, manganese, molybdenum, nickel, rubidium, silver, strontium, tin, titanium, tungsten, uranium, yttrium, zinc and zirconium. The primary task was to identify trace elements found in Denver's raw water sources and compare concentrations with those of treatment plant effluents. Chemical analyses were made of all water sources that con-

tribute to the effluent of the Denver Sewage disposal Plant No. 1. These included wells, springs and mountain streams west to Denver. Composite water samples representing three days collection were dried to a solid residue. They were then weighed and ignited to 1000 deg C for one hour to determine L.O.I. (loss on ignition). They were weighed again and loss of weight was calculated as percent L.O.I. The remainder of each sample was termed 'inorganic solids' and this portion was used for chemical analysis. The investigator found that the trace elements occur in the raw waters in detrimental concentrations only in the regions of origin. In such areas, greater treatment of water for domestic consumption is required. Trace elements in raw waters tend to remain in solution throughout domestic use. (Poertner-Chicago) W70-06915

DETERMINATION OF FLUORINE BY MICRO DIFFUSION AS APPLIED TO WASTE WATERS, RIVER SAMPLES AND EFFLUENTS,

Upper Tame Main Drainage Authority, Birmingham (England).

A. E. Hey, and S. H. Jenkins.
Water Research, Vol 3, No 12, p 901-906, 1969. 1 fig, 17 ref.

Descriptors: *Analytical techniques, *Fluorine, *Water analysis, Water pollution, Industrial water, Rivers, Waste water (Pollution), Water properties, Diffusion.

Identifiers: *Micro-diffusion technique, Alizarin complexan method, Polypropylene cell, Hexamethylidisiloxane.

This new method for the determination of fluorine in samples of waste waters, river waters, and industrial effluents employs micro-diffusion technique for the separation and concentration of fluorine. The content of the element is then determined by the alizarin complexan method. (Wilde-Wisconsin) W70-06970

A SYSTEM FOR THE ANALYSIS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN NATURAL WATERS,

Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics.

For primary bibliographic entry see Field 02K.
W70-07030

SOME MEASUREMENTS OF TOXICITY OF TANNERY AND TEXTILE WASTES AND THEIR COMPONENTS TO FISH BY BIO-ASSAYS,

For primary bibliographic entry see Field 05C.
W70-07047

VOIDANCE TIME FOR 23 SPECIES OF FISH,

Bureau of Sport Fisheries and Wildlife, Warm Springs, Ga. Southeastern Fish Control Lab.

Thomas H. Lane, and Howard N. Jackson.
For sale by the Superintendent of Documents, U.S. Government PRINTING Office, Washington, D.C., 20402 - Price \$0.35. In: Investigations in Fish Control, Report No. 33, 9 p, 1969. 4 tab, 2 figs, 14 refs.

Descriptors: *Bioassay, Colorimetry, Fish physiology, Digestion, Animal metabolism, Sunfishes, *Analytical techniques, Fish diets, Fish, *Laboratory equipment.

Identifiers: *Voidance time, *Digestion rates, Sudan III, Water temperature effects.

Observations on 23 species of fingerling-size bioassay fish indicated that voidance time (time required for food residues to pass through the alimentary canal) ranged from 12 to 108 hours. The period of time that fingerling-size fish should be held off feed before use in bioassays depends principally on the species, type of food, and temperature. If contamination of bioassays by food-waste feces is to be minimized, food should be withheld from most of the 23 species studied for 2 to 3 days before bioassay.

says. (See also W70-07146 and W70-07148) (Sjolseth-Washington) W70-07147

5B. Sources of Pollution

BIOCHEMICAL OXYGEN DEMAND, DISSOLVED OXYGEN, SELECTED NUTRIENTS, AND PESTICIDE RECORDS OF TEXAS SURFACE WATERS, 1968,

Geological Survey, Austin, Tex.

For primary bibliographic entry see Field 05A.
W70-06749

FARM NITRATES: NO MENACE TO THE RIO GRANDE.

Agricultural Research, Vol 18, No 10, p 3-4, April 1970. 2 p, 1 fig, 2 photo.

Descriptors: *Nitrates, *Rio Grande, *New Mexico, *Texas, Fertilizers, Water pollution sources, Water quality, Return flow, Leaching, Irrigation water.

Identifiers: Mesilla Valley (N Mex), Rincon Valley (N Mex), El Paso Valley (Tex).

As part of a 30-year study of salt-balance conditions in three irrigated areas along the river, NO₃-N content was measured over a period when nitrogen fertilizer increased from almost nothing to a high level. The overall NO₃-N concentration of the river did not increase, indicating no significant stream pollution by NO₃-N from nitrogen fertilizer. The three irrigated areas are the Rincon Valley (17,000 acres), farther downstream the Mesilla Valley (80,000 acres), and below that the El Paso Valley (52,000 acres). Water for irrigation is taken from the Rio Grande at various diversion dams. The drainage water returns to the river above the point where water is withdrawn for the next downstream irrigated area. (Knapp-USGS) W70-06763

THE VOLUMETRIC DETERMINATION OF SULFATE IN WASTE WATERS (IN RUSSIAN),

For primary bibliographic entry see Field 05A.

W70-06892

LIQUID WASTE DISPOSAL IN THE LAVA TERRANE OF CENTRAL OREGON,

Federal Water Pollution Control Administration, Corvallis, Oreg. Pacific Northwest Water Lab.

Jack E. Scea.

Available from the Clearinghouse as PB-191 874, \$3.00 in paper copy, \$0.65 in microfiche. Report No. FR-4, May 1968. 66 p, 15 tab, 20 fig, 3 plates, 11 ref.

Descriptors: *Drainage wells, *Sewage disposal, Groundwater geology, Oregon, *Waste water disposal, Disposal, Waste disposal, Lava.

Identifiers: Deschutes River Basin, *Disposal wells, Liquid waste disposal.

A large part of the Middle Deschutes Basin in Central Oregon is underlain by basaltic lava flows that restrict the construction of conventional drain fields for liquid waste disposal. Drilled disposal wells in the lava serve as the chief method of liquid waste disposal. The disposal wells are concentrated in the Bend, Redmond, and Madras areas. THEY RANGE FROM A FEW FEET TO OVER \$) FEET IN DEPTH. Large quantities of groundwater underlie these areas and are being developed for domestic water supplies. The injection of liquid waste into disposal wells and the construction of deep uncased water wells create a threat to water quality. The prevention of further drain well construction and the casing of all deep water wells are recommended.

W70-06962

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5B—Sources of Pollution

LIQUID WASTE DISPOSAL IN THE LAVA TERRANE OF CENTRAL OREGON (Appendix), Federal Water Pollution Control Administration, Corvallis, Oreg. Pacific Northwest Water Lab.

Jack E. Sceva.

Available from the Clearinghouse as PB-191 875, \$3.00 in paper copy, \$0.65 in microfiche. Report No. FR-4, May, 1968. 96 p, 15 tab.

Descriptors: *Drainage wells, *Sewage disposal, Groundwater geology, Oregon, *Waste water disposal, Disposal, Waste disposal, Lava.

Identifiers: Deschutes River Basin, *Disposal wells, Liquid waste disposal.

This appendix contains tables describing water wells, disposal wells, well logs, springs, and information on the chemical character of groundwater and liquid wastes in the Middle Deschutes Basin. W70-06963

BIODEGRADATION OF MALATHION,

Texas Univ., Arlington. Dept. of Civil Engineering; and Kentucky Univ., Lexington. Dept. of Sanitary Engineering.

Clifford W. Randall, and Robert A. Lauderdale.

Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 93, No SA 6, p 145-156, 1967. 7 fig, 1 tab, 14 ref.

Descriptors: *Biodegradation, *Pesticide kinetics, *Streams, Organic pesticides, Degradation (Stream), Aeration, Activated sludge, Toxicity, Acclimation, Predation, Insect control.

Identifiers: *Malathion, Microbial degradation, Short-term toxicity, Forest Service.

The effect of Malathion on microorganisms was studied by administering 100 milligrams per liter of normal substrate at 24-hour intervals. The toxicity of the chemical to a mixed aqueous biota was related to the density of organisms present rather than volume of water. A low Malathion:organism ratio stimulated microbial activity while a ratio exceeding 1:5 inhibited respiration of the system. Aerobic organisms were capable of consuming Malathion, especially in the absence of other substrata. The chemical in stream is dissipated by aeration and is subject to biodegradation, but it may exert a short-term toxic effect. (Wilde-Wisconsin) W70-06967

POLLUTION PROBLEMS IN IOWA,

Iowa Univ., Iowa City. State Hygienic Lab.

Robert L. Morris, and Lauren G. Johnson.

In: Water Resources of Iowa, Symposium Proceedings, Iowa Academy of Science at Univ of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, p 89-109, Jan 1970. 21 p 2 fig, 6 tab.

Descriptors: *Water pollution sources, *Water quality, *Iowa, Organic matter, Sewage treatment, Municipal wastes, Farm wastes, Pesticides, Water pollution control, Water quality control, Industrial wastes, Insecticides, Silt, Erosion.

The major sources of pollutants to the water resources of Iowa are agricultural, industrial and municipal wastes. Practically all of the urban population of Iowa is served by municipal waste treatment to an adequate extent. Most of the municipal treatment facilities on internal streams have secondary treatment which removes 85-95% of the organic load. All of Iowa's streams are subject to standards which adequately provide for public water supply, aquatic life propagation and growth, recreation, industrial and agricultural purposes. There are over 150,000 individual farmsteads in the State of Iowa, raising cattle, hogs, sheep, and poultry, having a population equivalent (PE) far exceeding the human population of the State. The excreta from these animals produce enormous amounts of carbonaceous and nitrogenous wastes of which large portions eventually reach water courses. An extensive amount of data on the en-

vironmental conditions with respect to pesticides have been gathered. A very important aspect of stream pollution is siltation. Iowa soils due to their peculiar structure and extensive cultivation are especially subject to erosion. (See also W70-06981). (Knapp-USGS) W70-06987

SOME FINITE DIFFERENCE SOLUTIONS FOR THE DISPERSION OF THERMAL SOURCES IN STEADY PRISMATIC FLOW,

Rutgers - The State Univ., New Brunswick, N.J.

R. C. Ahlert, G. Biguria, and J. Tarbell.

Water Resources Research, Vol 6, No 2, p 614-621, April 1970. 8 p, 4 tab, 10 ref. Project A-019-NJ.

Descriptors: *Diffusion, *Mathematical models, *Path of pollutants, Dispersion, Mixing, Thermal pollution, Diffusivity, Turbulent flow, Turbulence, Vortices, Eddies, Steady flow, Open channel flow.

Identifiers: Boussinesq equation, Eddy viscosity.

Mathematical models and numerical difference techniques simulate the dispersion of heated effluents in steady, prismatic flow. Isovelocity point and line sources of finite volumetric flow develop in a short-time region of the order of two depths. Dispersion of plane sources and developed sources of the point or line type occurs in a longtime regime and is variable in two dimensions with respect to both velocity and diffusivity. Short-time solutions serve as input to a general longtime finite difference scheme. Flow mechanics control dispersion in typical problems employing point and plane source configurations. (Knapp-USGS) W70-07014

NUTRIENT CYCLING,

Yale Univ., New Haven, Conn. School of Forestry; and Dartmouth Coll., Hanover, N.H. Dept. of Biological Sciences.

For primary bibliographic entry see Field 02K. W70-07094

5C. Effects of Pollution

THERMAL ADDITIONS AND EPIFAUNAL ORGANISMS AT CHALK POINT, MARYLAND,

Geological Survey, Washington, D.C.

J. W. Nauman, and R. L. Cory.

Chesapeake Science, Vol 10, No 3 and 4, p 218-226, September-December 1969. 9 p, 7 fig, 26 ref.

Descriptors: *Thermal pollution, *Environmental effects, *Aquatic environment, *Aquatic life, *Maryland, Water temperature, Aquatic microbiology, Heated water, Thermal powerplants, Productivity, Water pollution effects.

Identifiers: Epifauna, Chalk Point (Md).

Two sets of test panels, one in the intake and the other in the effluent canal of a steam-generating station, were submerged at monthly intervals in 1967. The panels were analyzed for epifaunal species composition, abundance, seasonal attachment, and total biomass production. The average surface-water temperature rose 6.3 C above ambient on the effluent side, and biomass production of the epifaunal organisms found there increased nearly three times that of the intake. An earlier and larger set of some attached organisms occurred in the effluent, but there was little change in species composition between the intake and effluent canals. During the summer when high surface-water temperatures prevailed, there seemed to be a reduced number or disappearance of flatworms and colonial hydroids, along with increased barnacle growth. (Knapp-USGS) W70-06782

EPIFAUNA AND THERMAL ADDITIONS IN THE UPPER PATUXENT RIVER ESTUARY,

Geological Survey, Washington, D.C.

R. L. Cory, and J. W. Nauman.

Chesapeake Science, Vol 10, No 3 and 4, p 210-217, September-December 1969. 8 p, 6 fig, 17 ref.

Descriptors: *Thermal pollution, *Environmental effects, *Aquatic environment, *Aquatic life, *Maryland, Water temperature, Water quality, Turbidity, Aquatic microbiology, Heated water, Thermal powerplants, Productivity, Water pollution effects.

Identifiers: *Upper Patuxent Estuary (Md).

In the upper Patuxent Estuary environmental changes in temperature, salinity, and turbidity over a 5-year period are linked to changes in epifaunal production and species distribution. During 1967 a series of monthly panels showed dry weight production averaged 2.8 times greater in a steam electric station heated effluent than in the intake. A downriver shift in epifaunal production in 1967 and changes in species abundance was noted and attributed to natural changes in salinity and turbidity and man-induced changes in temperature. (Knapp-USGS) W70-06783

PARTHION - USE OF BLOOD CONCENTRATION TO DIAGNOSE MORTALITY OF FISH,

Federal Water Pollution Control Administration, Cincinnati, Ohio.

For primary bibliographic entry see Field 05A. W70-06832

DDT RESIDUES ABSORBED FROM ORGANIC DETRITUS BY FIDDLER CRABS,

Miami, Univ., Fla. Inst. of Marine Science.

W. E. Odum, G. M. Woodwell, and C. F. Wurster. Science, Vol 164, p 576-577, May 1969. 1 fig, 16 ref.

Descriptors: *DDT, *Detritus, *Animal behavior, Crabs, Chlorinated hydrocarbon pesticides, Pesticide residues, Pesticide toxicity, Estuarine fisheries, Persistence, Bioassay.

Identifiers: *Fiddler Crabs, DDD, DDE.

The association of organic particulate matter in estuaries is significant because many organisms rely on such particles for food. The association of DDT residues with detritus particles of various sizes and the availability of these residues to the fiddler crab (*Uca pugnax*) were examined. Detritus particles from 500 to 1000 microns in diameter contained the highest DDT residues and were also the detritus ingested by many organisms. The transfer of DDT residues attached to organic detritus was studied using 45 fiddler crabs. Fifteen crabs were killed immediately; DDT residues in their claw muscle averaged 0.235 ppm. Fifteen crabs were used as controls and fed detritus containing 0.01 ppm DDT. The other 15 crabs were fed detritus containing 10.0 ppm DDT. After 10 days the control group appeared normal, but all crabs in the experimental group developed poor coordination by day 5. After 10 days the controls had .240 ppm and the experimental group had a mean DDT residue level of 0.885 ppm. (Sjolseth-Washington) W70-06833

ANALYSIS OF MERCURY OF FISHES AND SOILS OF AGANO RIVER (IN JAPANESE),

Tokyo Science Univ., (Japan).

Shunji Ishikura, and Shibuya, Chioko.

Eisei Kagaku, Vol. 14, No. 4, p 228-230, 1968. 3 tab, 1 fig.

Descriptors: *Soil analysis, *Degradation, *Water pollution effects, Heavy metals, Water analysis, Fishkill, Photometry.

Identifiers: *Mercury, Agano river, Japan, Tissue analyses.

The analysis of mercury was carried out to clear the cause of occurrence of poisoned patients caused by organic mercury around the Agano River. The mercury content was estimated photometrically from the mercury dithizonate which was isolated from dithizon extract of oxidative degradation

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product of samples such as soils, fishes and waters. It was found that the soils obtained near the draining exit of Shyowa Denko and Nippon Gas Kagaku contained high amount of mercury, whereas the mercury was not detected clearly in any waters. Some fishes were also found to keep the high concentration of the total mercury and organic mercury. (Sjolseth-Washington)
W70-06834

SPLEEN AND KIDNEY MASS - A MEASURE OF THE PHYSIOLOGICAL ACTIVITY OF THE CARP (CYPRINUS CARPIO L.) (IN GERMAN),

Marie-Luise Albrecht.
Zeitschrift für Fischerei, NF Band 17, Heft 1-4, p 79-100, 1969. 18 tab, 1 fig, 28 ref.

Descriptors: *Fish physiology, Carp, Stress.

Identifiers: *Spleen, *Kidney, Kidney atrophy, Spleen ischemia, Osmoregulation, Organ blood content.

Studies on the changes in size of spleen and kidney in carp under different conditions of life have shown that the shape of these organs, especially that of the spleen, may change considerably. It was observed that at relative inactivity (narcotization, low water temperatures) spleen and kidney of carp are full of blood. When in summer the activity of muscles is raised these organs deliver blood to the circulation system. When exposed for a long time to higher temperatures (30 deg C) spleen ischemia and kidney atrophy become especially evident. Stresses as oxygen deficit, catching, holding and transporting in tanks also effect the blood filling rate of organs and lead to blood delivery. These processes are controlled by nerves and hormones. Outbreaks of acute infectious dropsy in carp leads to swelling of spleen and kidney caused by failure of the osmo-regulating mechanism and so the water content of organs raises. Carp react very sensitively to every physiological stimulus, this is shown i.a. by the blood content of spleen and kidney. The state of these organs, especially that of the spleen may serve as indicator for the physiological condition both of individual fish and of the entire stock. (Sjolseth-Washington)
W70-06835

THE POLLUTION ENVIRONMENT,

Federal Water Pollution Control Administration, Washington, D.C.
William Marcus Ingram, and Kenneth M. Mackenthun.

In: Proceedings of the Second Annual American Water Resources Conference, American Water Resources Association, Urbana, Ill., 1966, p. 115-133, 11 fig, 2 tab, 15 ref.

Descriptors: *Water pollution, *Water pollution effects, *Industrial wastes, *Municipal wastes, *Public health, *Ecology, *Pollutants, *Standards, *Biochemical oxygen demand, Silts, Sewage, Textiles, Pulp and paper industry, Chemical wastes, Acid mine water.

Identifiers: *Stream ecology, *Water quality standards, *Ecological aspects, *Bear River, Utah, *Chattooga River, Georgia, *Menominee River, Michigan-Wisconsin, *East Pearl River, Mississippi, *Monongahela River, Pennsylvania, Forestry-wastes.

The effects of pollution, especially complex municipal and industrial wastes, upon the aquatic life in streams are presented. Examples of organisms that may inhabit clean and polluted waters are given. Polluted waters may stimulate organism associations that become nuisances to man, or carry disease; some species of phytoplankton have been incriminated in human reactions resulting in dysenteric disorders, systemic allergic reactions, and local allergic eruptions. Pollution affects organisms in various ways, and conversely, organisms have an effect on pollution. Those organisms that survive in a pollute environment use the pollutant material as food and in doing so exert a purification potential on the wastes. One manifestation is a reduction

in biochemical oxygen demand. Biological aspects of the pollutive environment are depicted in the paper including the effects of silts and sands associated with the Bear River in Utah; sewage, textile and other industrial wastes associated with the Chattooga River in Georgia; pulp and paper wastes associated with the Menominee River in Michigan and Wisconsin; forest products and chemical wastes associated with the East Pearl River in Mississippi; and acid mine discharges associated with the Monongahela River in Pennsylvania. The effects of various types of wastes on stream organisms are illustrated by several methods of graphical presentation; a different type of presentation was made for each waste. A list of measurements that can be considered in setting criteria and/or standards to protect water quality for multiple usage is presented. (Richmond-Chicago)
W70-06852

SOME SEWAGE PROBLEMS IN EUROPE TODAY,

Instituut voor Gezondheidstechniek TNO, Delft (Netherlands). Div. of Water and Soil Research. For primary bibliographic entry see Field 05D.
W70-06881

FISHES OF THE GREEN-DUWAMISH RIVER,

Seattle Metropolitan Municipality, Wash.
Robert I. Matsuda, Gary W. Issac, and Raymond D. Dalseg.
Water Quality Series No 4, December 20, 1968, 38 p, 4 fig, 3 tab, 6 ref, appendix.

Descriptors: *Fish populations, *Fishkill, *Water pollution effects, *Shiners, *Sculpins, *Chinook Salmon, *Fish types, Waste water, Waste water disposal, Effluents.

Identifiers: *Green-Duwamish River, *Renton Treatment Plant, *Seattle.

This is a summary of a three year (1964-1966) study of the effects of the effluents from the Renton Waste water Treatment Plant on the fishlife of the Green-Duwamish River. The study included only the four most abundant of the 30 varieties of fish found in the river—Shiner Perch, Staghorn Sculpin, Starry Flounder, and the Chinook Salmon. Since no historical study of the fishes of the river could be found, this documentation is an original report. The seasonal and yearly population fluctuations of the selected species were studied. The Shiner Perch and Staghorn Sculpin population increased. The Starry Flounder population remained constant. The number of Chinook Salmon declined at one station and was variable at the other. It was concluded that the overall effect of the Renton Water Treatment Plant on the Green-Duwamish River is not detrimental to fish and desirable aquatic organisms and that the treatment plant may have contributed to the increase in fish population of some species. As the human population increases and industries expand in the Metro Service area, requiring expansion of the Renton Treatment Plant to 10 times its present effluent discharge rate, it will be necessary to continue these studies to predict the effects of increased discharges on fish populations. (Poertner-Chicago)
W70-06913

A SURVEY OF STREAM CONDITIONING IN ISSAQAH CREEK,

Seattle Metropolitan Municipality, Wash.
Raymond D. Dalseg, Gary W. Issac, and Robert I. Matsuda.
Water Quality Series No. 3, March 1966. 24 p, 7 tab, 7 fig, 4 ref.

Descriptors: *Eutrophication, *Ecology, *Limnology, *Biocontrol, *Water pollution sources, Nutrients, Sampling, Chemical analysis, Monitoring, Water quality, Water pollution effects, Pollution abatement, Dairy industry, Sewage effluents. Identifiers: *Issaquah Creek, *Lake Sammamish, *Lake Washington, *Seattle.

This report is a survey of the water quality of Issaquah Creek. The creek is one of the main tributaries to Lake Sammamish which is eutrophying at a substantial rate. It was found that Issaquah Creek contributes the greatest amount of nutrients to the lake. Wastes are contributed to the stream by Darigold Dairy Products, Issaquah Sewage Treatment Plant, Lakeside Gravel, and Reid Sand and Gravel. Four sampling stations were set up by request to test Darigold's output to the creek from their treatment plant. A weekly sampling program was started in August, 1965. The multiple tube fermentation technique was used in coliform examination. Field inoculations were employed throughout the tests. Selected examinations were run for positive identification of the bacteria. It was found that the nutrient-rich effluent discharged into the stream may accelerate the eutrophication of Lake Sammamish. The completion of Metro's trunk sewer line to Issaquah in 1967 should provide the facilities to convey the effluents to Metro's Renton Wastewater Treatment Plant instead of Issaquah Creek. (Poertner-Chicago)
W70-06928

DISSIPATION OF ENDOTHALL AND EFFECTS ON AQUATIC WEEDS AND FISH,

California Univ., Davis, Dept. of Botany.
For primary bibliographic entry see Field 03F.
W70-06971

AN INTRODUCTION TO THE LIMNOLOGY OF HARTBEESPOORT DAM WITH SPECIAL REFERENCE TO THE EFFECT OF INDUSTRIAL AND DOMESTIC POLLUTION,

National Inst. for Water Research, Pretoria (South Africa).

B. R. Allanson, and J. M. T. M. Gieskes.
Hydrobiologia, Vol 18, p 77-94, 1961. 11 ref.

Descriptors: *Reservoirs, *Limnology, *Industrial wastes, *Water pollution effects, *Eutrophication, Dissolved oxygen, Hydrogen ion concentration, Epilimnion, Photosynthesis, Algae, Bottom sediments, Thermocline, Hypolimnion, Animals, Density, Iron, Phosphorus, Silica, Sampling, Chemical analysis, Physical properties, Carp, Tilapia, Temperature, Nutrients, Phytoplankton, Cyanophyta, Nitrogen, Oligochaetes, Diptera.

Identifiers: *Hartbeespoort Dam (South Africa), Transparency, Marginal vegetation fauna, Sandy bottoms fauna, Marginal vegetation, Microcystis, Anabaena, Eucyclops, Nais, Cricotopus, Austracloeo, Enallagma, Pseudagrion, Brachythemis, Chydorus, Pleuroxus, Tanypus, Tanytarsus, Limnodrilus, Eucyclops, Alona, Chaoborus.

The correlated data of this study of water mass in South Africa contribute to knowledge of pollution effects in a reservoir. Hartbeespoort Dam is eutrophic with a low transparency developed during the past 25 years. Monomictic with complete circulation during winter months, low dissolved oxygen concentrations throughout the reservoir often result. Nutrients are contributed by the Jukse-Crocodile River system and to a lesser degree from the Magalies River. Rises in the epilimnetic pH were mainly caused by photosynthetic activity of algae in the presence of moderately basic water. Bottom sediments in the deeper portion of the reservoir underwent rapid anaerobiosis after the establishment of a thermocline and oxycline in summer. Fauna density in the bottom sediments decreases rapidly with the establishment of the hypolimnion. Sediments are rich in iron and during summer there was an increase in the ferrous component. The soluble and acid soluble phosphorus increases in the hypolimnion after a winter minimum. Silica content is comparable with productive water masses in other parts of the world. Faunal associations are typical of other moderately basic and highly productive water in the same geographical region of South Africa. (Jones-Wisconsin)
W70-06975

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5C—Effects of Pollution

PHYTOPLANKTON,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 02H.
W70-06976

POLLUTION PROBLEMS IN IOWA,
Iowa Univ., Iowa City, State Hygienic Lab.
For primary bibliographic entry see Field 05B.
W70-06987

REPORT ON THE BIOLOGICAL FINDINGS OF THE HUDSON RIVER FISHERIES INVESTIGATIONS, 1965-1968,
Hudson River Technical Committee, Cornwall, N.Y.
For primary bibliographic entry see Field 06G.
W70-07024

A COMPOSITE RATING OF ALGAE TOLERATING ORGANIC POLLUTION,
Robert A. Taft Water Research Center, Cincinnati, Ohio. Advanced Waste Treatment Research Lab. C. Mervin Palmer.
Journal of Phycology, Vol 5, No 1, p 78-82, 1969. 5 p, 11 tab, 29 ref.

Descriptors: *Algae, *Bioindicators, *Water pollution effects, *Reviews, *Water quality, Water pollution, Organic matter, Bibliographies.
Identifiers: Pollution-tolerant algae.

A review of pollution-tolerant algae using reports from 165 authors shows that the genera and species most often referred to as significant fall into a relatively stable series. Diatoms, pigmented flagellates, green, and blue-green algae are all well represented among the pollution-tolerant genera and species. *Euglena*, *Oscillatoria*, *Chlamydomonas*, *Scenedesmus*, *Chlorella*, *Nitzschia*, *Navicula*, and *Stigeoclonium* are the most tolerant genera, and *Euglena viridis*, *Nitzschia palea*, *Oscillatoria limosa*, *Scenedesmus quadricauda*, and *Oscillatoria tenuis* are the most tolerant species. In some genera, for example *Euglena*, a single tolerant species is far more significant than all others. In other genera, as in *Oscillatoria*, only a slight difference distinguishes the pollution tolerance of two or more species. Algal pollution indices are presented for use in rating water samples with high organic pollution. (Knapp-USGS)
W70-07027

SOME MEASUREMENTS OF TOXICITY OF TANNERY AND TEXTILE WASTES AND THEIR COMPONENTS TO FISH BY BIO-ASSAYS,
J. David, and P. Roy.
Indian Journal of Fisheries, Vol 7, p 423-442, 1960.

Descriptors: *Fish, Chlorine, *Toxicity, Textiles.
Identifiers: *Dyehouse wastes, *Statistical analysis, Textile mill wastes, Bleaching, Dyeing, Kiering, Caustic.

During a study of pollution in the river Ganga at Kanpur, India, the toxicity of various tannery and textile waste waters were investigated by bio-assay techniques, using small carp and cat fish as the test fish. Results are tabulated showing the physical and chemical characteristics of three textile waste waters, namely kier, dye, and bleach liquors and the percentage of survival and median tolerance limits for the test fish at different concentrations of these waste waters. The results are analyzed statistically and discussed in relation to the composition of the waste waters. It is concluded that kier liquor is harmless above 19-25 times dilution and dye liquor is less harmless than kier liquor; but bleach liquor is very toxic owing to the presence of chlorine and was the only liquor which in minute concentrations proved fatal to fish. (Livengood and Work-North Carolina State Univ)
W70-07047

INFLUENCE OF MOLOYBDENUM ON THE TROUT AND TROUT FISHING OF CASTLE LAKE,
California State Dept. of Fish and Game, Sacramento, Inland Fisheries Branch.
Almo J. Cordone, and Stephen J. Nicola.
California Fish and Game, Vol. 56, No. 2, p 96-108. 1970. 5 figs, 6 tab, 9 refs.

Descriptors: *Molybdenum, *Fertilization, Fertilizers, Fishfood organisms, *Fish populations, Fish harvest, Fish management, *Nutrient requirements, Productivity, Rainbow trout, Brook trout, *Fish harvest, Fishing, Zooplankton.
Identifiers: *Fish production, *Sodium molybdate, Castle Lake, California.

The addition of 35 ob. of sodium molybdate ($\text{Na}_2\text{Mo}_4 \cdot 2\text{H}_2\text{O}$) to Castle Lake, California, in July 1963 was followed by record yields to the angler of rainbow trout in 1966, and eastern brook trout in 1967. The increase each year was approximately 3.5 lb per acre greater than the average annual yield for the period 1960-1965. Estimated cost per additional pound of trout in the creel was less than \$0.10. High survival of the 1965 year class of both species was responsible for the increased yield. Greater standing crops of zooplankton and bottom fauna very likely promoted the improved survival. Changes in growth rates of trout following fertilization were not significant. The strong 1965 year classes apparently reduced survival of subsequent year classes. Factors other than fertilization may have influenced the high survival of the 1965 year classes. These include (i) the size and condition of rainbow trout when stocked, (ii) the density of resident rainbow trout when a plant was made, and (iii) a record December 1964 flood. Because of the doubts created by these factors, a second experimental molybdenum addition has been made. (Sjolseth and Katz-Washington)
W70-07137

PESTICIDE CONCENTRATIONS IN GREAT LAKES FISH,
Bureau of Commercial Fisheries, Ann Arbor, Mich. Great Lakes Fishery Lab.
Robert E. Reinert.
Contrib. No. 371 of Great Lakes Fishery Laboratory. Pesticides Monitoring Journal, Vol. 3, No. 4, p 233-240, March 1970. 8 tab, 1 fig, 8 refs.

Descriptors: *Great Lakes, *Dieldrin, *DDT, Chlorinated hydrocarbon pesticides, *Pesticide residues, Lake Michigan, Gas chromatography, Lake Erie, Lake trout, Lake Huron, Lake Ontario, Lake Superior, Pesticide removal.
Identifiers: DDD, DDE, Alewife.

Reports on a 4 year study by Ann Arbor Great Lakes Fishery Laboratory of the Bureau of Commercial Fisheries on insecticide levels in fish from the Great Lakes. The two insecticides found in all Great Lakes fish have been DDT (DDT, DDD, DDE) and dieldrin. Fish from Lake Michigan contain from 2 to 7 times as much of these insecticides as those from the other Great Lakes. Insecticide levels calculated on a whole-fish basis show a marked difference from species to species. Within a species there is also an increase in DDT and dieldrin levels with an increase in size. If these insecticide levels are, however, calculated as ppm of insecticide in the extractable fish oil, the differences in concentration between species and the differences between size groups becomes considerably less. Laboratory experiments indicate that fish can build up concentrations of DDT and dieldrin at the parts-per-million level from parts-per-trillion concentrations in the water. (Sjolseth-Washington)
W70-07138

MARINE PHYTOPLANKTON VARY IN THEIR RESPONSE TO CHLORINATED HYDROCARBONS,
Woods Hole Oceanographic Institution, Mass.
David W. Menzel, Judith Anderson, and Ann Randtke.

Contrib. No. 2424 from Woods Hole Ocean. Inst. Science, Vol. 167, p 1724-1726, March 1970. 1 fig, 9 refs. NSF Grant GB 15103 AEC Contract AT (30-1)-3862.

Descriptors: *DDT, *Dieldrin, *Endrin, Chlorinated hydrocarbon pesticides, Pesticide toxicity, Pesticide removal, *Photosynthesis, Water pollution effects, *Phytoplankton, Diatoms, Inhibition, Inhibitors, Resistance.

Identifiers: *Marine phytoplankton, Skeletonema costatum, *Dunaliella tertiolecta*, *Coccilithus huxleyi*, *Cyclotella nana*.

Photosynthesis and growth in cultures of four marine phytoplankton species, (*Skeletonema costatum*), (*Dunaliella tertiolecta*), (*Coccilithus huxleyi*), and (*Cyclotella nana*) isolated from different oceanic environments, were affected by three chlorinated hydrocarbons (DDT, dieldrin, and endrin) to varying extents. This ranged from complete insensitivity in *Dunaliella* to toxicity at concentrations of 0.1 to 1.0 part per billion of the pesticides in *Cyclotella*. Other forms were intermediate in their response. (Sjolseth and Katz-Washington)
W70-07139

THE CHRONIC TOXICITY OF LINEAR ALKYLATE SULFONATE (LAS) TO PIMEPHALES PROMELAS RAFINESQUE,
Federal Water Pollution Control Administration, Cincinnati, Ohio. Newtown Fish Toxicology Lab. Quentin H. Pickering, and Thomas O. Thatcher. Journal of the Water Pollution Control Federation, Part I, p 243-254, Feb. 1970. 9 tab, 28 ref.

Descriptors: *Linear alkylate sulfonates, *Bioassay, *Toxicity, *Detergents, Mortality, Water pollution effects, *Lethal limit, *Growth rates, Fecundity.

Identifiers: *Chronic toxicity, *Pimephales promelas, Median tolerance limits, Biodegradation, *Hatchability, Fry survival.

The primary objective of this bioassay was to determine the chronic toxicity of Linear Alkylate Sulfonate to the fathead minnow using 'laboratory fish production index' as the measure of effect. The results of this study indicate that lethality of LAS to newly hatched fry was the most critical factor found within the precision of testing methods. An experimental concentration of 0.63 mg/l LAS was determined as the maximum acceptable concentration. The application factor for LAS for this species and water lies between 0.63/4.35 and 1.2/4.35 or approximately 14 and 28 percent of the 96-hr TLm value. A LAS concentration between 14 and 28 percent of the 96-hr TLm value concentration, determined with the species of concern may estimate the maximum acceptable concentration for long-term exposure of these species. This application factor for LAS was the largest of any toxicant studied at the Newtown fish Toxicology Laboratory. (Sjolseth-Washington)
W70-07140

AN ANALYSIS OF VARIATION OF INSECTICIDE RESIDUES IN LANDLOCKED ATLANTIC SALMON (SALMO SALAR)
Maine Dept. of Inland Fisheries and Game, Augusta.
Richard B. Anderson, and Owen C. Fenderson. Journal of the Fisheries Research Board of Canada, Vol. 27, p 1-11, 1970. 4 tab, 2 fig, 8 refs.

Descriptors: Maine, *Atlantic Salmon, *Pesticide residues, Pesticides, Variability, *DDT, Chlorinated hydrocarbon pesticides, *Evaluation, *Dieldrin, Water pollution effects, *Analytical techniques, Age.

Identifiers: *Sebago Lake, Maine, *DDD, *DDE, *Analysis of variance fat content.

High variation in yearly samples of insecticide residues found in landlocked salmon from Sebago Lake, Maine, has necessitated an evaluation of

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sampling methods and an investigation of causes of variation. A sample of 59 male salmon, composed of ages III+, IV+, and V+, and representing fish in poor and good body condition was collected from a spawning run in the fall of 1967 and analyzed for DDT, DDD, DDE, dieldrin, and fat content. Levels of insecticide residues were found to be highly dependent on age and fat content. DDD and DDE increased with age and fat content, and dieldrin increased with fat content. Age and fat content were interdependent in their effects on DDT levels. DDT was significantly higher in high-fat than in low-fat fish at ages III+ and IV+ but not at age V+, showing a decrease with age among fish with high fat content and remaining constant with age among fish with low fat content. It is recommended that completely random selection of fish for insecticide analyses be abandoned in favor of stratification by sex, age, and fatness. Some of the possible causes of variation in insecticide content of salmon are discussed. (Sjolseth-Washington) W70-07141

INFLUENCE OF TEMPERATURE CHANGE ON SPONTANEOUS LOCOMOTOR ACTIVITY AND OXYGEN CONSUMPTION OF ATLANTIC SALMON, *Salmo salar*, ACCLIMATED TO TWO TEMPERATURES.

Carleton Univ., Ottawa (Ontario). Dept. of Biology.

R. H. Peterson, and J. M. Anderson.

Journal of the Fisheries Research Board of Canada, Vol. 26, p 93-109, 1969. 11 figs, 20 refs.

Descriptors: Atlantic salmon, Oxygen requirements, Water temperature, Thermal stress, *Acclimatization, *Animal metabolism, Respiration, *Fish physiology, Fish behavior.

Identifiers: *Oxygen consumption, *Temperature change, *Spontaneous locomotor activity, Standard metabolic rate, Fish activity, Temperature effects.

Measurements of the effect of rapid change in temperature on the spontaneous activity and oxygen consumption were made on Atlantic salmon underyearlings acclimated to 6 or 18°C. The new levels of imposed temperature ranged from 6 to 30°C for both acclimations. At similar test temperatures the calculated standard metabolic rate of the fish acclimated to 6°C was higher than that of the fish acclimated to 18°C, up to about 23°C, where the two curves relating oxygen consumption and temperature intersect. Spontaneous activity could be separated into two phases, a transient phase occurring during the actual period of temperature change, and a stabilized phase. The transient phase was characterized by a peak in activity which was found to be correlated with the rate, rather than the amount, of the temperature change. The relation between activity in the stabilized phase and test temperature was characterized by a plateau or maximum in the general region of the previously determined selected temperature. Complete acclimation for both metabolism and activity, between 6 and 18°C, requires about 2 weeks, regardless of the direction of the temperature change. (Sjolseth and Katz-Washington) W70-07142

EFFECTS OF TEMPERATURE AND BODY WEIGHT ON ENDOGENOUS NITROGEN EXCRETION IN THE BLUEGILL SUNFISH (*Lepomis macrochirus*).

Indiana Univ., Bloomington. Dept. of Zoology.

Jan Savitz.

Journal of the Fisheries Research Board of Canada, Vol. 26, p 1813-1821, 1969. 4 tab, 2 fig, 21 ref.

Descriptors: *Fish physiology, *Thermal stress, *Water temperature, Acclimatization, *Animal metabolism.

Identifiers: *Bluegill Sunfish (*Lepomis macrochirus*), Temperature effects, *Endogenous nitrogen excretion rate, effects of body weight, *Protein maintenance level.

The effects of temperature and body weight on endogenous nitrogen excretion (ENE) rate were examined for fish acclimated at 7.2, 15.6, 23.9, and 29.4-32°C. Nitrogen excretion rates were very high at the highest temperature and decreased with a decrease in acclimated temperature from 29.4-32.2°C to 15.6°C. Nitrogen excretion rates were equal at 15.6 and 7.2°C. From these data, an estimate of maintenance protein for a population of bluegill sunfish (*Lepomis macrochirus*) was calculated on a seasonal and yearly basis. (Sjolseth and Katz-Washington) W70-07143

RELATIONSHIP OF RIVER POLLUTION TO BACTERIAL INFECTION IN SALMON (*Salmo salar*) AND SUCKERS (*Catostomus commersoni*).

Fisheries Research Board of Canada, St. Andrews (New Brunswick).

John H. Pippy, and Gerard M. Hare.

Transactions of the American Fisheries Society, Vol. 98, No. 4, p 685-690, Oct 1969. 4 fig, 9 ref.

Descriptors: Atlantic salmon, Sculpers, Catostomids, Pseudomonas, Aquatic bacteria, *Bacteria, *Fish diseases, Fishkill, *Mortality, Epizootiology, Water pollution effects, Heavy metals, *Copper, Water temperature, Fish behavior.

Identifiers: *Catostomus commersoni, *Aeromonas liquefaciens, *Epizootic, Miramichi River, New Brunswick, *Zinc.

During the summers of 1967 and 1968, the pseudomonad bacterium, *Aeromonas liquefaciens*, was involved in disease of Atlantic Salmon (*Salmo salar*) and suckers (*Catostomus*) in the Miramichi River, New Brunswick. The symptoms of this disease were ulcers and degenerated caudal, pelvic, and dorsal fins. A surge of copper and zinc pollution on late June 1967, and high river temperatures 22.5 deg C enhanced production of an epizootic. The epizootic recurred during the summer of 1968. (Sjolseth and Katz-Washington) W70-07144

EFFECTS OF pH OF CULTURE WATER ON THE GROWTH OF THE JAPANESE PEARL OYSTER (IN JAPANESE).

National Pearl Research Lab., Ago (Japan).

Yukimasa Kuwayata, and Nishii Tamotsu.

English summary. Bulletin of the Japanese Society of Scientific Fisheries, Vol. 35, No. 4, p 342-350, 1969. 14 fig, 15 refs.

Descriptors: *Hydrogen ion concentration, Cultural control, Oysters, *Water quality, Water quality control, *Growth rates, Alkalinity, Ammonia, Nitrates, Mortality, Calcium, Phosphates.

Identifiers: Japanese Pearl oyster, *Pinctada fucata, *Culture water.

Thirty five one-year-old pearl oysters were equally divided into 7 groups, which were reared in separate recirculating tanks for 40 days. The pH of water of the experimental tanks was first adjusted to 6 different levels from 7.3 to 8.1 by adding necessary amounts of hydrochloric acid or sodium borate. Average pH values of culture water throughout the rearing period were 7.36, 7.48, 7.66, 7.78, 7.89 and 8.07 in the 6 experimental tanks and 8.04 in a control. The oysters in pH 8.07 and control tanks showed a rapid growth throughout the rearing period. Among the other oyster groups it was found that a decrease in oyster weight was directly related to pH. Most oysters reared in pH 7.36 and 7.48 died during the first half of rearing period. The relation between the weekly mean pH value and the daily weight increase differed with the stage of rearing. Oyster weight increases at pH, above 7.8 and decreases at lower pH during the first 19 days. After 20 days the relation is linear, being represented with the following expression: G (mg) = 29.589 pH - 234.794. Where G and pH show the weekly mean of daily increase of oyster weight and pH after 20 days. The limiting pH

for growth is estimated to be pH 7.935. It was concluded that the decrease in under-water weight of the oysters reared in low pH is mainly due to the dissolving of the shell rather than the decrease in the meat weight. (Sjolseth and Katz-Washington) W70-07145

TOXICITY OF HYAMINE 3500 TO FISH,

Bureau of Sport Fisheries and Wildlife, Warm Springs, Ga. Southeastern Fish Control Lab.

James W. Hogan.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402 - Price \$0.35. In: Investigations in Fish Control, Rpt No. 32, 7 p, 1969. 8 tab, 7 ref.

Descriptors: *Bioassay, Mortality, *Toxicity, Hydrogen ion concentration, Lethal limit, Warmwater fish, Resistance, Bass.

Identifiers: *Hyamine 3500, *LC 50, Temperature effects, Goldfish, Effects of water quality.

Toxicity of Hyamine 3500 (a microbicide) to three species of trout and 11 species of warmwater fish was determined in static bioassays. Twenty-nine lots of fish from nine sources were used in water at various levels of pH, temperature, and total hardness. Hyamine 3500 is more toxic in alkaline or acidic water than in water with a pH of 7. In general, toxicity varies directly with temperature and inversely with total hardness. Dilute solutions of Hyamine 3500 appear to degrade rapidly in open vessels. (See also W70-07147 and W70-07148) (Sjolseth-Washington) W70-07146

VOIDANCE TIME FOR 23 SPECIES OF FISH,

Bureau of Sport Fisheries and Wildlife, Warm Springs, Ga. Southeastern Fish Control Lab.

For primary bibliographic entry see Field 05A. W70-07147

LABORATORY STUDIES ON POSSIBLE FISH-COLLECTING AIDS WITH SOME TOXICITIES FOR THE ISOMERS OF CRESOL,

Bureau of Sport Fisheries and Wildlife, LaCrosse, Wis. Fish Control Lab.

Robert M. Howland.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402 - Price \$0.35. In: Investigations in Fish Control, Report No. 34, 10 p, 1969. 17 refs, 3 tables, 2 figs.

Descriptors: *Bioassays, Laboratory experiment, Laboratory tests, Lethal limit, *Toxicity, Fishkill, *Fish physiology, *Fish control agents, Rainbow trout, Brown trout, Brook trout, Lotic environment, Resistance.

Identifiers: LC 50, *Quinaldine, *McNeil-Jr-7464, *MS-222, *Cresol, *Fish collecting agents.

The relative merits of quinaldine McNeil-JR-7464, and three isomers of cresol (p-methylphenol, o-methylphenol, and m-methylphenol) as collecting agents were determined in a lotic system under laboratory conditions at 12 deg C. The toxicity of the three cresol isomers to rainbow trout, brown trout, and brook trout also was measured in bioassays conducted in standard constituted water, and LC50 values were calculated for exposures of 6, 24, 48, and 96 hours. The toxicity of para-cresol was also established for carp, fathead minnow, black bullhead, channel catfish, bluegill, and yellow perch. Conclusions of these toxicity and efficacy tests were as follows: (1) Para-cresol is the most active toxic of the three isomers of cresol; (2) The cresols are too harsh physiologically as fish-collecting agents; (3) MS-222 is not well suited as a fish-collecting tool; (4) Quinaldine may have some usefulness for collecting fish in small streams with rapid flow; (5) McNeil-JR-7464 does not induce surfacing but is effective at low concentrations and appears to have desirable characteristics as a fish-collecting agent. (See also W70-07147 and W70-07146) (Sjolseth-Washington) W70-07148

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5C—Effects of Pollution

5D. Waste Treatment Processes

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS,
Nebraska Univ., Lincoln.
For primary bibliographic entry see Field 03A.
W70-06755

IMPROVEMENTS IN TREATMENT DESIGN FOR ENHANCING WASTE WATER QUALITY,
Washington Univ., Seattle. Dept. of Civil Engineering.

Dale A. Carlson, and H. Kirk Willard.
Washington University Water Research Center
Final Project Report for FY 1968, July 11, 1968.
17p, 13 fig, 20 ref, append. OWRR Project No A-016-WASH.

Descriptors: *Tertiary treatment, *Aerobic treatment, Oxygen demand, Biochemical oxygen demand, Suspended load, Solids contact process, Sewage treatment, Trickling filters, Waste water treatment, Phosphates, Nitrates, Algae.
Identifiers: Solids removal.

A new two-phase biological tertiary waste treatment system includes an aerobic bacterial growth unit and a particulate removal unit. In the removal unit, the effects of suspended solids loading on a community of attached particulate feeding organisms were determined. A biomass yield of 16% of the influent suspended solids for the particulate feeders produced a low effluent solids concentration of only 0.069 mg suspended solids per mg B. O. D. removed. This dense material was found to settle rapidly. Total dissolved organic carbon was over 90% destroyed. Similar removal values of 90 to 94% were measured for B. O. D. The decreases of both organic carbon and B. O. D. were higher at lower loading rates. Most nitrogen compounds were oxidized to nitrates. As expected, the percent of nitrification decreased with increased loading. Phosphates were not removed except for the amount incorporated into wasted cell biomass ranging in magnitude from 22 to 36%. (Knapp-USGS)

W70-06792

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOL. IV. PROJECTED WASTE WATER TREATMENT COSTS IN THE ORGANIC CHEMICALS INDUSTRY.
Rice (Cyrus Wm.) and Co., Pittsburgh, Pa.
For primary bibliographic entry see Field 06B.
W70-06841

ESTIMATING CONSTRUCTION COSTS OF WASTE WATER TREATMENT SYSTEMS,
Auburn Univ., Ala. School of Engineering.
James C. Farrow, Leo J. Hirth, and Joseph F. Judkins, Jr.
Textile Chemist and Colorist. Vol 2, No 3, p 35-40,
February 11, 1970. 2 tab, 14 fig, 9 ref. OWRR Project A-008-ALA (3).

Descriptors: *Aeration, *Biochemical Oxygen Demand, *Costs, *Cost analysis, *Waste water treatments, *Textiles, Effluents, Waste treatment, Alabama, Georgia, Trickling filters, Activated sludge, Fibers (Plant).

A survey revealed that waste water from 30 textile plants in Alabama and West Georgia is discharged principally to city sewers with some prior treatment. Flowrates vary from 0.03 to 7.00 million gallons per day with BOD rates as high as 40,000 lbs a day. Using estimation methods for BOD based on cloth production and processing operations, construction costs (excluding land) are estimated for trickling filter, activated sludge and mechanically aerated treatment units. The costs are for waste water flowrates from 0.25 to 6.00 million gallons a day with BOD parameters of 300, 450 and 700 ppm. Mechanical aeration offers the lowest cost.
W70-06842

COMPUTER AIDED DESIGN OF WASTE COLLECTION AND TREATMENT SYSTEMS,
Michigan Univ., Ann Arbor.
For primary bibliographic entry see Field 06A.
W70-06849

SLUDGE DISPOSAL ALTERNATIVES--SOCIO-ECONOMIC CONSIDERATIONS,
Washington Univ., Seattle.

Brian W. Mar.
Journal of the Water Pollution Control Federation, Vol 41, No 4, April 1969, p 547-552, 2 fig, 11 ref.

Descriptors: *Costs, *Sludge disposal, Waste water treatment, Social aspects, Economics, Waste treatment, Ultimate disposal.
Identifiers: *Muddling process, Environmental control.

The necessity for socio-economic considerations in relation to sludge disposal are discussed. Results of analyses indicate that sludge disposal is not a major system consideration in a waste water management system unless only primary treatment is used. The amount of treatment for sludge prior to discharge should be decided on a socio-economic basis rather than technical considerations. The decision is made through a muddling process rather than through a logical basis, and most economic arguments do not consider shifts in social preferences nor total social costs. The costs of discharging the residue to the less sensitive element of the environment will be small compared to the total cost of maintaining the environment. Resources normally devoted to reducing the cost of sludge disposal should be directed toward reducing the cost of major element of environmental pollution. The alternative to this would be to collect the equivalent of the discharge treatment costs for the period prior to environmental damage and then use these funds to compensate those parties suffering damage and to provide treatment necessary to reduce damages to a socially acceptable level. In either situation, it is the socio-economic forces that will establish the criteria for sludge disposal. (Shankar-Texas)
W70-06862

IMPROVED SUBSURFACE DISPOSAL,

Public Health Service, Cincinnati, Ohio. Div. of Water Supply and Pollution Control.
Ronald A. Popkin, and Thomas W. Bendixen.
Journal Water Pollution Control Federation, Vol 40, No 8, p 1499-1514, Aug 1968. 15 fig, 5 tab, 10 ref.

Descriptors: *Waste water disposal, *Subsurface flow, *Water quality, Hydraulics, Chemical oxygen demand, Adsorption, Ultimate disposal, Filters, Groundwater, Tertiary treatment, Waste water treatment, Trickling filters, Effluents.
Identifiers: *Dosing rate, Primary effluent, Septic systems.

In the application of liquid waste to soil both continued hydraulic acceptance and quality of the percolate must be considered. Laboratory studies revealed that hydraulic acceptance as measured by the rate of wetted new surface area in a progressive ponding situation is influenced by the frequency of applying waste, the volume of waste applied, and the quality of waste applied. The rate of development of wetted absorption area decreases with decreased frequency of application and improved quality of waste applied. Within limits the efficiency of use of absorption area was improved with higher loading rates. That is, the rate of using cell did not increase as rapidly as the loading rate. The quality of the percolate improved with time after a relatively poor initial period. The results of these studies suggest that the design and operation of soil absorption system can be improved through use of once a week dosing and/or by use of improved pretreatment without impairing groundwater quality.
W70-06863

PUBLIC ATTITUDES TOWARD USE OF RECLAIMED WASTE WATER,
California Univ., Berkeley.
William H. Bruvold, and Paul C. Ward.
Water and Sewage Works, Vol 117, No 4, p 120-122, April 1970. 2 tab, 2 ref.

Descriptors: *Water reuse, *Attitudes, *Reclaimed water, Surveys, California, Costs, Recreation facilities, Recreation, Social aspects.
Identifiers: *Public opinion.

A survey was made of two towns in California to determine the attitudes of the public concerning the uses of reclaimed waste water. Initial surveys yielded information about the public use in evaluation of reclamation projects which had been underway for some period of time. Additionally, attitudes toward a wide range of uses of reclaimed water were assessed in order to supplement the major data regarding existing reclamation projects. The results revealed that the facilities supplied with reclaimed water received moderate use by the households interviewed with recreational lakes receiving the highest degree of patronage, and that very few generally negative evaluations of water supplying these facilities were given. It should be emphasized that the questions employed to obtain the above information were administered before any reference was made to reclaimed waste water. A SECOND SET OF DATA IN CONTRAST TO THE PREVIOUS SURVEY WAS OBTAINED BY DIRECT REFERENCE TO POTENTIAL USES OF RECLAIMED WATER IN OR NEAR THE COMMUNITY BEING STUDIED. The results showed that the amount of expressed opposition to particular uses of reclaimed water is directly related to degree of contact and that expressed opposition drops off sharply after use of reclaimed water for swimming. (Hancock-Texas)
W70-06864

BACTERIAL PHOTOSYNTHESIS IN THE OXIDATION PONDS OF AHMEDABAD, INDIA,
Central Public Health Engineering Research Inst., Ahmedabad (India). Field Centre.
Indira S. Jayangoudar.

Water and Sewage Works, Vol 115, No. 8, p 380-383, Aug 1968. 1 fig, 3 tab, 20 ref.

Descriptors: *Oxidation lagoons, *Photosynthetic bacteria, Biochemical Oxygen Demand, Dissolved oxygen, Hydrogen sulfide, Sewage treatment, Waste water treatment.
Identifiers: *Ahmedabad, India, Purple sulfur bacteria, Thiopedia rosea.

The phenomenon of bacterial photosynthesis, an anaerobic process, has been attributed to two selective groups of eubacteria. Thiorhodaceae, the purple colored sulfur bacteria, and Athiorhodaceae, the purple colored sulfurless bacteria, depend primarily upon light as an energy source and carry on a photosynthetic mode of metabolism. The origin, development, and ecology of *Thiopedia rosea* Winogradsky are discussed. On one occasion the bacterium was found to proliferate in the presence of a considerable amount of dissolved oxygen and on other occasions in the presence or absence of hydrogen sulfide. With the occurrence of *Thiopedia rosea* in the ponds, there was a considerable reduction in BOD ranging between 57.7% to 73.5%. Therefore, it would appear that the occurrence of purple colored sulfur bacteria in oxidation ponds does not affect their efficiency. Bacterial photosynthesis, occurring on the bottom layers of oxidation ponds, is believed to utilize solar radiation in the short infrared region of the spectrum. (Aguirre-Texas)
W70-06865

CATTLE, SWINE AND CHICKEN MANURE CHALLENGES WASTE DISPOSAL METHODS,
Connecticut Univ., Storrs.
R. Laak.

Water and Sewage Works, Vol 117, No 4, p 134-138, April 1970. 8 tab, 30 ref.

Waste Treatment Processes—Group 5D

Descriptors: *Agriculture, *Cattle, Waste water (Pollution), Costs, Nitrogen, Phosphorous, Potash, Fertilizers, Disposal, Pollution, Livestock, *Hogs, Poultry, Nitrogen compounds, Phosphorus compounds, *Farm wastes.

Identifiers: Chicken, Feedlots.

In the United States today approximately 0.66 billion lbs per day of manure must be extensively treated or destroyed. The trends in agriculture indicate that more livestock will be confined in the future, the concentration of the wastes increased, and the volume of manure per animal slowly reduced. Extensive data was collected and is presented giving the general characteristics of feces and urine of cattle, swine, and poultry as well as the quantitative consumption of feed, nitrogen, phosphorous, and potash. The manure characteristics are said to be changing and therefore the treatment process principles must also be changed. Costs and land requirements are given for manure disposal and an extensive outline enumerates the large variety of available disposal methods along with each one's particular drawback. The average cost of manure separation and final disposal must be a fraction of \$3 to \$40 per ton. (Hancuff-Texas) W70-06866

GAS-LIQUID CHROMATOGRAPHIC TECHNIQUES FOR PETROCHEMICAL WASTE WATER,
Union Carbide Corp., South Charleston, W. Va.
For primary bibliographic entry see Field 05A.
W70-06867

A TOTAL SYSTEMS APPROACH TO POLLUTION CONTROL AT A PULP AND PAPER MILL,
Proctor and Gamble Co., Cincinnati, Ohio.
C. A. Barton, J. F. Byrd, R. C. Peterson, J. H. Walter, and T. H. Woodruff.
Journal of the Water Pollution Control Federation, Vol 40, No. 8, p 1471-1485, Aug 1968. 10 fig, 3 ref.

Descriptors: *Industrial wastes, *Waste water treatment, *Pulp wastes, Sewage treatment, Monitoring, Flotation, Evaporation, Aeration, Activated sludge.

Identifiers: *Paper making, Combustion.

A new pulp and paper mill on the Susquehanna River at Mehoopany, Pa. was designed with a 6 million dollar pollution control facility as an integral part. Spent liquors from the sulfite pulping process, high in oxygen demand, but low in suspended solids are concentrated and burned. The BOD's of the unconcentrated waste are from 30,000 mg/l to 40,000 mg/l. The more dilute pulping wastes are treated by activated sludge process. White water from paper making is screened, passed through an aeration flotation unit, and recirculated. Wastes from leaks and spills are treated by rotary screening. The emergency holding basins are provided to prevent untreated or inadequately treated discharges from reaching the river. The monitoring network samples the effluent, provides continuous analysis for pH, suspended solids, and total carbon, and checks river quality. (Hancuff-Texas)
W70-06868

COST OF CONVENTIONAL AND ADVANCED TREATMENT OF WASTE WATER,
Robert A. Taft Water Research Center, Cincinnati, Ohio. Advanced Waste Treatment Research Lab.
Robert Smith.
Journal of the Water Pollution Control Federation, Vol 40, No 9, p 1546-1574, Sept 1968. 31 fig, 9 tab, 23 ref.

Descriptors: *Costs, *Waste water treatment, Operation and Maintenance, Construction costs, Activated sludge, Trickling filter, Filtration, Activated carbon, Electrodialysis, Surveys, Chlorination, Pipelines, Ultimate disposal.
Identifiers: Primary treatment, Ammonia stripping, Microstraining, Aerator, Final Settling.

The cost associated with building and operating waste water treatment plants in individual waste water processes are presented. The information from several sources is brought together, using a consistent set of assumptions and omissions, for a useful working document. The majority of the results are presented graphically with the cost in cents per thousand gallons plotted against design capacity in million of gallons per day. Most of the curves vary between 1 and 100 million gallons per day. Some of the costs presented include primary, activated sludge, and trickling filter plant capital, operation, and maintenance costs; coagulation and sedimentation costs; filtration, adsorption, DO, and chlorination costs; control house costs; and many others. (Hancuff-Texas)
W70-06869

PROFESSIONALISM AND WATER POLLUTION CONTROL IN GREATER CHICAGO,
Metropolitan Sanitary District of Greater Chicago, Ill.

Vinton W. Bacon, and Frank E. Dalton.
Journal of the Water Pollution Control Federation, Vol 40, No 9, p 1586-1600, Sept 1968. 15 fig, 1 tab.

Descriptors: *Sewage treatment, *Sewage disposal, *History, Financing, Sewers, Sludge disposal, Costs, Lagoons, Activated sludge, Underground storage, Water pollution, Waste water treatment, Professional personnel.

Identifiers: *Chicago, Combined sewers, Regional planning.

The Metropolitan Sanitary District of Greater Chicago formed in 1889, has successfully kept pollution out of the areas water supply and water recreation. The initial phase involved construction of canals to convey wastes over a low divide away from Lake Michigan to tributaries of the Mississippi River system. The need for lessening pollution in these channels led to construction of waste water treatment plants, the largest of which treats one billion gallons a day. Because of urban growth and higher water quality standards \$713,000,000 worth of new facilities will be needed by the year 2000. These will include solids disposal by reclamation of marginal and strip mine land and underground storage system for combined sewer storm flows, tertiary treatment, and chlorination. Professionalism is needed to guide these developments and to make problems and recommended solutions understood by public officials. (Hancuff-Texas)
W70-06871

CONVERSION TO ACTIVATED SLUDGE AT UNION CARBIDE'S INSTITUTE PLANT,
Union Carbide Corp., South Charleston, W. Va.

G. W. Kumke, J. F. Hall, and R. W. Oeben.
Journal of the Water Pollution Control Federation, Vol 40, No 8, p 1408-1422, Aug 1968. 9 fig, 10 tab, 4 ref.

Descriptors: *Activated sludge, *Aeration, *Industrial wastes, Performance, Biochemical Oxygen Demand, Chemical oxygen demand, Sludge disposal, Instrumentation, Ponds, Sewage treatment, Stabilization, West Virginia, Waste water treatment, Biomass.

Identifiers: *Plant scale, Aerators, Institute (W Va).

To provide additional treatment of waste water for a petrochemical plant at Institute, West Virginia the existing aerated stabilization facility was converted to a completely mixed flocculant growth process. Selection of the process and equipment was based on the laboratory and pilot-scale studies. The addition consisted of doubling the surface aeration capacity to 2,000 hp adding two 70-foot-diameter peripheral feed clarifiers and providing biomass recycling equipment. The completed facility allows for an 80% increase in organic removal, from 50,000 lbs BOD per day to about 90,000 lbs BOD per day. Test work was undertaken to evaluate the change in biomass and operating conditions. Performance was monitored with con-

ventional as well as total carbon chromatographic methods. The effects of aerator interaction on mixing and biomass diffusion was studied in the full scale basis. Hydraulic and specific organic effects on biomass separation were studied through dye dispersion and settleability tests. The applicability of various types of equipment including centrifuges, vibrating screens, hydraulic cyclones, and gravity thickeners to biomass dewatering also was investigated. (Hancuff-Texas)
W70-06872

THE SUGAR INDUSTRY IN PUERTO RICO AND ITS RELATION TO AN INDUSTRIAL WASTE PROBLEM,
Puerto Rico Univ., San Juan. School of Medicine.

Nelson Biaggi.

Journal of the Water Pollution Control Federation, Vol 40, No 8, p 1423-1433, Aug 1968. 3 fig, 6 tab, 2 ref.

Descriptors: *Industrial wastes, *Disposal, *Puerto Rico, *Sugarcane, Biochemical Oxygen Demand, Cooling water, Waste disposal, Water pollution.

Identifiers: Molasses, Filter cake, Sugars, Bagasse.

Although the sugar industry in Puerto Rico is declining it poses continuous waste problems. The wastes described are: cane fiber, filter cake, cooling, and condenser waters, and concentrated wastes from spillage, leaks, and washings. The cane fiber is usually disposed of through burning and in many cases supplies all the fuel required to supply the factory. The filter cake is the waste resulting from the clarification of the juices. It is suggested that the filter cake be used as a fertilizer rather than placed in a body of water. Cooling and condenser waters have a BOD of 100 mg/l due to entrainment of sugar. The suggested solution is the reduction of losses and re-circulation. The concentrated wastes though low in volume may have extremely high oxygen demands. It is suggested that the government give financial incentives for waste control particularly that accomplished by in-plant measures rather than treatment. (Hancuff-Texas)
W70-06873

JET AERATION IN ACTIVATED SLUDGE SYSTEMS,

Houdaille Industries, Inc., Prophetstown, Ill.; and Iowa Univ., Ames.

Richard W. West, and Wayne L. Paulson.

Journal of the Water Pollution Control Federation, Vol 41, No. 10, Oct. 1969, p 1726-1736. 8 fig, 1 tab, 11 ref.

Descriptors: *Activated sludge, *Aeration, *Costs, Efficiency, Mass transfer, Submergence, Waste water treatment, Sewage treatment.

Identifiers: *Jet aeration, *System design, Aerator submergence, Waste treatment basin, Piping distribution.

A jet aerator development program and system design study that extends the original work from particular operating conditions to the full spectrum of fluid flow, submergence, and system design is described. Jet aerator performance was analyzed under standard test conditions and the oxygen absorption values per unit of power input were found to be in range similar to other types of aeration devices. It was shown that with optimum liquid flow rate, aeration efficiency improved with decreasing air flow rates. Jet aerator systems provide complete mixing of aeration basin contents and can easily be adopted to automated control of air flow rates for optimum system performance. Guidelines are recommended for selection of aeration system components. A typical layout is presented to illustrate system design for optimum performance in activated sludge waste-water treatment units. (Shankar-Texas)
W70-06874

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

CASE HISTORY OF WASTE WATER TREATMENT ON A GENERAL ELECTRIC APPLIANCE PLANT,

General Electric Co., Schenectady, N.Y.

J. S. Anderson, and E. H. Iobst, Jr.

Journal of the Water Pollution Control Federation, Vol 40, No 10, p 1786-1795, Oct 1968. 12 fig, 9 tab, 4 ref.

Descriptors: *Industrial wastes, *Waste water treatment, History, Costs, Operations, Aluminum, Metals.

Identifiers: General Electric, Allentown (Pa), Nickel, Caustic wastes, Solids.

Waste water discharges from a small appliance plant are treated to remove metal ions, acids, and alkali. The current average flow is 230 million gallons per year. The initial equipment installed and the manner in which the treatment system had been expanded to keep pace with expanding manufacturing operations are discussed. Specifically covered are: (1) description of the sources of waste waters generated, (2) volumes of waste water, (3) analysis of waste streams, (4) treatment plant performance, (5) costs, amounts, and frequency of use, (6) labor, maintenance, and utility expenses, and (7) annual fixed costs of operation. (Hancuff-Texas)

W70-06876

FREEZING METHODS USED TO CONDITION ACTIVATED SLUDGE,

Rex Chainbelt Inc., Milwaukee, Wis.

William J. Katz, and Donald G. Mason.

Water and Sewage Works, Vol 117, No 4, p 110-114, April 1970. 9 fig, 13 ref.

Descriptors: *Sludge treatment, *Filtration, *Freeze-thaw test, Pilot plants, Freezing, Activated sludge, Dissolved solids, Suspended solids.

Identifiers: *Conditioning, Loading, Filter cake, Wire screen cloth.

During the last few years a renewed attention has been placed on physical methods of sludge conditioning in an attempt to eliminate the need for chemical conditioners. The freezing of activated sludge causes the suspended solids to agglomerate and form relatively large floc particles. Upon thawing these floc particles separate rapidly leaving a clear supernatant and occupy significantly less volume than before freezing. A pilot scale study was made to determine the effectiveness of freezing as a conditioner of activated sludge. The sludge concentrations used during the study ranged from 1 to 2.5%. After freezing the sludge was thawed and gravity filtered by various size wire screens, 140-24 mesh placed in a 9 cm buchner funnel. The screens had an effective area of 0.0575 sq ft. Results of this study showed that a solid production rate of 36 to 57 lbs of dry solids per sq ft per hour was attainable. This figure is 10 to 20 times higher than that which would be expected from vacuum filtration of the same sludge. The filtrate quality obtained was less than 750 mg/l of suspended solids. This compares with a vacuum filter filtrate of 500 mg/l to 10,000 mg/l. Despite the encouraging results obtained by freezing conditioning methods development of the process was limited for the following reasons: (1) high cost and consumption of power, (2) high capital and operating costs and (3) frequent washing of filter media. (Hancuff-Texas)

W70-06877

EVALUATION OF THE JERIS RAPID COD TEST,

San Antonio, Tex.

W. N. Wells.

Water and Sewage Works, Vol 117, No 4, p 123-129, April 1970. 12 fig, 8 tab, 5 ref.

Descriptors: *Chemical Oxygen Demand, *Evaluation, *Biochemical Oxygen Demand, Temperature, Waste water treatment.

Identifiers: *Jeris-Chemical oxygen demand, Total organic carbon, Standard methods, Glucose, Glutamic acid.

The rapid COD test developed by Jeris (Water and Wastes Engineering 4:89, 1967) has not received wide attention and acceptance. The small amount of special equipment required, the speed with which the test results are obtained, and the precision of the results are remarkable. The rapid COD tests consists of oxidizing the sample by heating in the presence of a mixture of strong acids, potassium dichromate, and a catalyst to a definite temperature 165 deg C and then titrating the excess dichromate with standard ferrous ammonium sulfate using ferroin as an indicator. Extensive investigations were made on the effects of sample volume, temperature, digestion time, dilution, and heat destruction of dichromate. A battery of tests were also made correlating the BOD₅ and the rapid COD test for both raw waste water and effluent from secondary treatment. The results showed a fairly close correlation between COD and BOD values. When testing a glucose glutamic mixture the variation of COD values were within the standard deviations suggested by Standard Methods for the BOD analysis. (Hancuff-Texas)

W70-06878

SOLIDS RETENTION IN ANAEROBIC WASTE WATER TREATMENT SYSTEMS,

Kansas Univ., Lawrence. Environmental Health Engineering Lab.

R. Dague, R. E. McKinney, and J. T. Pfeffer.

Journal of the Water Pollution Control Federation, Vol 42, No 2, p R29-R43, February 1970. 6 fig, 6 tab, 29 ref.

Descriptors: *Anaerobic digestion, *Performance, Chemical precipitation, *Anaerobic bacteria, *Flocculation, Waste water treatment, Sludge, Chemical Oxygen Demand, Hydrogen ion concentration.

Identifiers: *Solids retention time, *Ferrous chloride, Topeka (Kan).

The results from a laboratory investigation of the biological solids retention time aspects of anaerobic waste treatment are presented. The minimum solids retention time for the domestic waste water sludge substrate utilized and a temperature of 35 deg C was found to be 30 days. A solids retention time of 10 days or more was required to prevent wash-out of key organisms and a resulting rapid decrease in process efficiency. Anaerobic biological solids can be flocculated in a manner similar to aerobic sludges, but excessive turbulence can destroy flocculation. An intermittent mixing study showed that intermittent mixing significantly improved the biological flocculation and solids separation resulting in a significant decrease in the effluent volatile solids concentration. Chemical coagulation can be used to aid separation of anaerobic biological solids. Chemical coagulation of the effluent and return of the precipitated sludge was carried out by raising the pH of the effluent to 8.3 with sodium by dioxide followed by the addition of sufficient ferrous chloride ($FeCl_2 \cdot H_2O$) to form a readily-settleable floc. COD removal efficiencies averaged 96.3 percent. Viable methane organisms can be returned to the system by this method of chemical coagulation. (Galwardi-Texas)

W70-06879

THE ANAEROBIC FILTER FOR WASTE TREATMENT,

Stanford Univ., Calif. Dept. of Civil Engineering.

J. C. Young, and P. L. McCarty.

Journal of the Water Pollution Control Federation, Vol 41, No 5, Part 2, p R160-R173, May 1969. 7 fig, 5 tab, 9 ref.

Descriptors: *Anaerobic digestion, *Performance, *Filtration, *Pilot plants, Chemical Oxygen Demand (COD), Sludge, Waste treatment.

Identifiers: *Anaerobic filter, *Loading rates, Solids production.

Effective treatment of low strength soluble organic wastes was accomplished using an anaerobic filter. Long biological solids retention times, efficient operation at 25 deg C, low solids production, low

head losses and the lack of requirements for mixing, heating and recirculation were some of the advantages presented for the anaerobic filter process. Six-feet-tall, six-inches-diameter columns filled with quartzite stone were used to treat protein and protein carbohydrate waters at loadings of 26.5 to 212 lb chemical oxygen demand/day/1000 cu.ft. Detention times varied from 4.5 to 72 hrs. Start-up results showed the merit of using a heavy bottom seed as compared to a light uniform seed. Results from tests on loading rate variations on a given filter showed that a loading rate of 26.5 lb COD/day/1000 cu ft, 93% COD removal was obtained while at a loading rate of 212 lb COD/day/1000 cu ft only 60% COD removal was obtained. It was noted that treatment efficiency did not improve greatly with heights greater than 4 feet. (Galwardi-Texas)

W70-06880

SOME SEWAGE PROBLEMS IN EUROPE TODAY,

Instituut voor Gezondheidstechniek TNO, Delft (Netherlands). Div. of Water and Soil Research.

J. K. Baars.

Water Pollution Control, Vol 68, No 5, p 529-534, 1969. 5 tab, 12 ref.

Descriptors: *Eutrophication, *Nitrogen, *Phosphorus, *Detergents, *Phenols, Waste treatment, Waste disposal, Waste water (Pollution), Water Quality, Costs, Capital costs, Waste water treatment.

Identifiers: Population equivalents, Oxidation ditch.

Several European waste water treatment problems including eutrophication, nitrogen and phosphorus removal, detergents, insecticides, and phenols are discussed. The facilities, capital and operating costs of several European treatment plants are also discussed. Some 10,000 metric tons of phenols or about two-thirds of the phenols released by the coking plants in the Emscher and Lippe River basins are intercepted and treated yearly in 25 dephenolating plants. The 'inhabitant equivalent,' widely defined as equal to 54 g BOD/day, is not regarded as reliable for design. Instead, the actual loading should be used for design. Several European countries have outlawed the use of 'hard' detergents due to their residual effects in water. Surface active substances have been found to influence the oxygen exchange coefficient in water. Undesirable algae growths occur when the phosphorus concentration exceeds 0.1 mg/l and the nitrogen concentration exceeds 0.3 mg/l. The average daily human excretions contain 0.7-3.7 g of P, of which 50-60% is in the urine. Modern detergents contain 37-48% phosphates on a dry basis. Experimentation is in progress to replace phosphates by nitrilo triacetate. Phosphorus can be effectively removed by chemical precipitation. Using lime $Ca(OH)_2$ as a coagulant, 93.4% P removal was obtained at a dosage of 1.5 times the carbonate hardness as $CaCO_3$. International cooperation on river basin or regional scope is needed to curb pollution in Europe. (Makela-Texas)

W70-06881

HIGH QUALITY REUSE WATER BY CHEMICAL-PHYSICAL WASTE WATER TREATMENT,

New York Univ., Bronx.

Matthew M. Zuckerman, and Alan H. Molof.

Journal of the Water Pollution Control Federation, Vol. 42, No. 3, p 437-456, March 1970. 14 fig, 5 tab, 25 ref.

Descriptors: *Hydrolysis, *Activated carbon, *Waste water treatment, Water reuse, Hydrogen ion concentration, Activated sludge, Chemical oxygen demand, Costs, Biological treatment.

Identifiers: *Chemical-physical treatment, *Colloidal organics, Soluble organics, Molecular weight distribution.

Waste Treatment Processes—Group 5D

With the increasing demand for high quality water for reuse, an effort is made to maximize the effectiveness of activated carbon adsorption. Increasing the pH to a value of 11.5 is reported to cause chemical hydrolysis. This hydrolysis pre-treatment before activated carbon adsorption results in a better quality water for raw waste water than for activated sludge effluent when both are subjected to the same pre-adsorption chemical hydrolysis. The conventional tertiary treatment which includes activated sludge treatment was found to be inferior, both qualitatively and economically to the chemical pre-treatment followed by activated carbon treatment. (Hancuff-Texas)
W70-06882

NITROGEN REDUCTION BY SYSTEM ALTERATION,
Toronto Univ. (Ontario).
A. L. Atkinson.
Water and Pollution Control, Vol 69, No 2, p 20-21, February 1970. 2 fig.

Descriptors: *Sewage treatment, *Nitrogen, Activated sludge, Nutrients, Sludge disposal, Waste water treatment, Waste treatment, Nitrification, Denitrification.

Identifiers: *Process modification, Ash Bridge Bay, Toronto.

A study was conducted in 1968 at the main sewage treatment plant in Ash Bridge Bay, Toronto to determine what process modifications could be made to limit the nitrogen effluent from the existing plants. The treatment plant consists of a conventional activated sludge plant complete with two stage digestion, vacuum filtration and incineration. Waste streams of activated sludge, digester overflow, spent elutriating water and filtrate are recycled to the primary settling tanks. Samples of the above waste streams were collected and analyzed for all forms of nitrogen. A nitrogen balance for each unit process was calculated. The recycled liquors while amounting to only 4% of the raw sewage flow contained 56% of the raw sewage nitrogen. Laboratory tests on a combination of the four recycled streams showed that sedimentation could produce a sludge of 3% consistency which contained 75% of the nitrogen. This sludge could be vacuumed filtered along with digested sludge and the nitrogen would be permanently removed. (Hancuff-Texas)
W70-06883

DRYING OF SAND-DIGESTED SLUDGE MIXTURES,
Washington Univ., Seattle. Dept. of Civil Engineering.

M. E. Harper, and B. W. Mar.
Journal of the Sanitary Engineering Division, Proceedings of the ASCE, Vol 96, No SA2, p 381-393, April 1970. 8 fig, 5 tab, 10 ref.

Descriptors: *Sludge disposal, *Sludge digestion, *Drying, Sewage sludge, Sewage treatment, Design, Sands, Centrifugation, Waste treatment. Identifiers: *Falling-rate period, Design equation.

An empirical design equation was developed to estimate the drying rate during the falling-rate drying period of a mixture of sand and centrifuged digested primary domestic sewage sludge to be used as a fill material. The average moisture content calculated from the drying rate was required in order to facilitate placement of the fill in the field at maximum density. Data were collected over a nine-month period to develop the design equation. Three different sands with sand to sludge dry solids ratios ranging from 0:1 to 30:1 were used. The primary variables considered were sand to sludge dry weight ratio, ambient temperature, and ambient relative humidity. The mean error found between the experimental and predicted drying rates from the design equation was 35% with a standard deviation of error equal to 25%. The failure to include air velocity in the design equation and the source of weather data were postulated as being the major

cause for this error. Mixture depth and sand particle size were not found to affect drying rates for the ranges and distributions tested. The design equation was not verified for polymer treated sludges. (Galwardi-Texas)
W70-06884

COMPARISON OF VARIOUS NITROGEN SOURCES IN ANAEROBIC TREATMENT,
Manhattan Coll., Bronx, N.Y. Dept. of Civil Engineering.

R. Gasser, and J. S. Jeris.
Journal of the Water Pollution Control Federation, Vol 41, No 2, Part 2, p R91-R100, February 1969. 4 fig, 7 tab, 5 ref.

Descriptors: *Anaerobic digestion, *Nutrient requirements, *Nitrogen compounds, Laboratory tests, Industrial wastes, Chemical Oxygen Demand (COD), Waste treatment, Sewage treatment.

Identifiers: *Ammonium chloride, *Sodium nitrate, *Ammonium nitrate.

The effects of various nitrogen nutrients on the anaerobic treatment of a nitrogen-deficient industrial waste were investigated. Batch laboratory-scale digesters operated at 35 deg C and a detention time of 12 days were fed a mixture having a COD of 7400 mg/l which was 89 percent corn-starch and 11 percent corn syrup. Both mixed and unmixed conditions were investigated in each instance. NH4Cl, NaNO3 and NH4NO3 in concentrations ranging from 2.8 to 156.8 mg/l were used as nitrogen sources. Results of the unmixed systems showed that about 80% COD removal was obtained using the higher concentrations of nitrogen, while only 67% removal was obtained at the lower nitrogen concentrations. Results of the mixed systems showed that about 74, 43 and 60 percent COD removal was obtained using the higher concentrations of NH4Cl, NaNO3 and NH4NO3 respectively. COD removal of 71, 19 and 21 percent were obtained using the lower concentrations of these nitrogen sources. NH4Cl, at both concentrations utilized, proved to be the most efficient source of nitrogen during the mixed phase. It was noted that less nitrogen was used for satisfactory treatment of the unmixed systems than for the mixed systems. (Galwardi-Texas)
W70-06885

U-TUBE AERATION OPERATING CHARACTERISTICS,

New Mexico State Univ., Las Cruces.
Richard E. Speece, Jack L. Adams, and Carolyn B. Wooldridge.

Journal of the Sanitary Engineering Division, ASCE, Vol 95, No SA3, p 563-574, June 1969. 12 fig, 1 tab, 1 ref. OWRR Project A-011-NMEX.

Descriptors: *Aeration, *Head loss, *Dissolved oxygen, Velocity, Dimensional analysis, Pilot plants, Waste water treatment, Reservoirs, Fish hatcheries.

Identifiers: *U-Tube aeration, Depth of submergence, Air-water ratio.

A modification of U-tube aeration, which injected air into the system with an air disperser instead of drawing air into the system by a flow constriction, was studied on a pilot scale. Advantages of the modification include more operational flexibility and less hydraulic head loss. Four-inch-diameter pipe was used as the pilot aerator and depths of 10, 20, 30 and 40 feet were studied at water flow rates of .22 to .73 fps, air water ratios of 0 to 26 percent, and disperser submergence of 1 to 35 feet. Variables measured included head loss due to air injection (ΔH) and change in dissolved oxygen (ΔDO). Increasing the percentage of air to water increased ΔDO at a diminishing rate. Increased depth of aerator submergence reduced ΔDO and ΔH for a given air water ratio. Higher velocities resulted in a slight reduction of ΔH and ΔDO . For other variables constant, both ΔH and ΔDO were found to be a function of U-tube depth. The U-tubes system favors

deeper depths, larger installations and higher velocities to minimize overall transfer costs. Dimensional analysis was performed. (DiFilippo-Texas)
W70-06886

BIOCHEMICAL DECOMPOSITION OF THE HERBICIDE N-(3,4-DICHLOROPHENYL)-2-METHYL PENTANAMIDE AND RELATED COMPOUNDS,

Rutgers - The State Univ., New Brunswick, N.J.
Nagim El-Din Sharabi, and Lucien M. Bordeleau.
Applied Microbiology, Vol. 18, No. 3, p 369-375, September 1969. 4 fig, 2 tab, 12 ref.

Descriptors: *Herbicides, *Biodegradation, *Hydrolysis, Isolation, Fungi, Enzymes, Degradation (Decomposition), Kinetics.

Identifiers: *Karsil, *Organisms.

A group of organisms were isolated, identified and tested for their ability to hydrolyze N-(3,4-Dichlorophenyl)-2-Methylpentanamide (Karsil). The rate of decomposition by 3 fungi with the herbicide as the sole carbon source is presented. The measurements are based on the accumulation of the product 3, 4, dichloroaniline (DCA). The enzyme Karsil Acylamidase was induced in a partially purified stage and tested for its ability to hydrolyze 25 related compounds. Some relations between structures of these compounds and their susceptibility to enzymatic hydrolysis were discerned. (Hancuff-Texas)
W70-06887

THEORETICAL CONCEPT OF GRAVITY SLUDGE THICKENING SCALING-UP LABORATORY UNITS TO PROTOTYPE DESIGN,

Texas Univ., Austin.
Howard J. Edde, and W. Wesley Eckenfelder Jr.
Journal of the Water Pollution Control Federation, Vol 40, No 8, p 1486-1498, Aug 1968. 11 fig, 2 tab, 28 ref.

Descriptors: *Sludge, *Mathematical model, *Design, Models, Sewage treatment, Sludge disposal, Waste water treatment.

Identifiers: *Thickeners, Solids.

Principle parameters involved in batch and continuous thickening operations and the use of these parameters to develop a mathematical model for the design of continuous thickening units were established. Five types of sludges were investigated. Significant parameters studied were feed, and underflow solids, concentrations, settling column heights, mass loading, rheological properties of the sludge, solids detention time, and sludge blanket depth. The results showed that both batch and continuous systems can be described by the mathematical model designed by the relationship $Cu/Co=1=D/(ML)^n$. The parameters Cu and Co are underflow and feed concentrations, while ML is the mass loading in psf/day lb solids/day/sq ft. The exponent n, describes the rheological properties of the sludge and is a constant for a specific sludge. The constant D is used to correlate batch and continuous systems and depends on feed concentration, detention time, and sludge blanket depth. This model provides a rational method for design of continuous thickeners from laboratory data. (Hancuff-Texas)
W70-06888

A CHEMICAL-PHYSICAL WASTE WATER RENOVATION PROCESS FOR KRAFT PULP AND PAPER WASTES,

Louisiana State Univ., Baton Rouge.
Donald R. Smith, and Herbert F. Berger.
Journal of the Water Pollution Control Federation, Vol 40, No 9, p 1575-1581, Sept 1968. 4 fig, 2 tab, 18 ref.

Descriptors: *Industrial wastes, *Water reuse, Waste water treatment, Biochemical Oxygen De-

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

mand, Color, Dissolved solids, Biological treatment, Activated carbon, Costs, Demineralization, Lime, *Pulp and paper industry.

Identifiers: *Chemical-physical treatment, *Kraft pulp.

The nature of pulp and paper wastes make it difficult to obtain the necessary reduction of BOD, color, and dissolved solids with a single treatment process. Proposed is an overall treatment scheme which handles the waste water step wise to produce a reusable process water. A four stage process utilizing lime dosing, biological treatment, activated carbon filtration, and demineralization was used on bleached and unbleached craft, total mill effluent. A three stage system without biological treatment also was tested. Biochemical oxygen demand (BOD) and color removal were 97% and 99.5%, respectively, for four stage; and 85.5% and 99.5%, respectively, for three stage. Cost comparisons are made. The four stage processed reusable water would cost approximately 4.5 cents/1000 gallons, and the three stage process would cost approximately 10 cents/1000 gallons. (Hancuff-Texas)

W70-06889

DATA PROCESSING IN PHILADELPHIA,

Philadelphia Water Dept., Pa.

Carmen F. Guarino, and Joseph V. Radziul.

Journal of the Water Pollution Control Federation, Vol 40, No 8, p 1385-1396, August 1968. 11 fig.

Descriptors: *Waste water treatment, *Data processing, *Computers, Activated sludge, Logging, Operations, Monitoring.

Identifiers: *Programming, Reports, Fortran II, Fortran IV, Philadelphia.

Efficient operation of Northeast high aeration plant in Philadelphia, Pa. requires the monthly tabulation of 12,000 operational entries comprising a monthly and annual report. To minimize the time required to prepare such reports, and to keep the plant operation up to date, a General Electric Data logging program using the Philadelphia Water Departments 1620 IBM computer in Fortran II language was prepared. The program includes statistical analysis, warnings, and daily, weekly, monthly, and yearly outputs. The current run time of 6.75 hours is expected to be cut to 1.5 hours with the use of Fortran IV and the IBM 1130. The programming will be expanded to include two similar Philadelphia plants with flows of 136 million gallons per day each. (Hancuff-Texas)

W70-06890

SLUDGE HANDLING,

Potter (Alexander) Association, New York.

Anton E. Sparr.

Journal of the Water Pollution Control Federation, Vol 40, No 8, p 1434-1442, Aug 1968. 6 fig, 2 ref.

Descriptors: *Sludge disposal, *Sludge digestion, Settling basins, Chemical treatment, Dewatering, Incineration, Waste water treatment, Sludge.

Identifiers: *Sludge handling, *Operator, Drying beds, Sea disposal.

Evaluation of sludge handling techniques is given from an operational standpoint. The problems are discussed with sedimentation tanks, digesters, drying beds, sea disposal, and chemical treatment. Mechanical dewatering devices which are discussed include vacuum filters, filter presses, centrifuges, and gravitational devices. Incinerators are also discussed. The processes of wet-air oxidation, multiple hearth furnace burning fluidized bed incineration and cyclone incinerations are included. Methods and problems are discussed in detail. (Hancuff-Texas)

W70-06891

HYDROGEN SULFIDE DAMAGE TO CONCRETE PIPE,

Seattle Metropolitan Municipality, Wash.

James E. Hawthorn.

Journal of the Water Pollution Control Federation, Vol 42, No 3, p 425-430, March 1970. 11 fig.

Descriptors: *Hydrogen sulfide, *Concrete pipes, *Corrosion, Pipelines, Sewers, Operation and maintenance, Odor, Pipes, Conveyance structures. Identifiers: *Waste water collection system, Wet well, Wash main, Interception lines, TV camera, Sulfuric acid.

Experiences of the municipality of metropolitan Seattle in hydrogen sulfide corrosion of the waste water system are cited. The greatest potential for concrete damage due to hydrogen sulfide exists at the discharge point of a waste water force main. Therefore, a long force main was used in the study. In the absence of free oxygen, sulfides are produced in waste water by the action of anaerobic bacteria on sulfate. The resulting hydrogen sulfide is highly soluble in water and is retained in solution until the waste water is released to atmospheric conditions. A concrete gravity line at the end of the force main being studied was inspected through the use of a television. The results showed the crown to be severely corroded and the corrosion seemed to lessen with the distance downstream. Chlorination of the most upstream wet well suppressed the hydrogen sulfide generation to a degree that no visible sign of concrete deterioration was evident. (Hancuff-Texas)

W70-06893

THE USE OF FLY ASH IN CONDITIONING BIOLOGICAL SLUDGES FOR VACUUM FILTRATION,

Notre Dame Univ., Ind.

Mark W. Tenney, and Gerald T. Cole.

Journal of the Water Pollution Control Federation, Vol 40, No 8, Part 2, p R281-R302, August 1968. 11 fig, 3 tab, 3 ref.

Descriptors: *Fly ash, *Sludge treatment, *Filters, Disposal, Dewatering, Hydrogen ion concentration, Activated sludge, Incineration, Organics, Laboratory tests, Phosphorus, Waste water treatment.

Identifiers: *Vacuum filtration, *Biological sludge, Flocculation, Sludge conditioning.

Buchner funnel tests were used to determine the effectiveness of fly ash as a conditioner of waste activated and digested sludges prior to vacuum filtration. The study revealed that the most desirable fly ash for dewatering of biological sludges is one with a high carbon content and a particle size in the range of 10 - 30 microns. A dosage of 50 grams per liter was shown to be optimum for all phases of the process including dewatering, fuel value, filtrate quality, etc. Results of experimental data on activated sludge dewatering showed that this dosage results in: (a) dewatering near optimum, (b) percent moisture content of cake almost reduced to its minimum value, (c) cake value with the highest fuel value and (d) complete phosphate removal. The values for these removals are 50% organic removal, 95% residual soluble orthophosphate removal, reduction from 84% to 63% moisture content. (Hancuff-Texas)

W70-06894

MEASUREMENT OF FILM ACCUMULATION IN A TRICKLING FILTER BY NEUTRON MODERATION,

North Carolina State Univ., Raleigh.

Jess A. Sullins, Jr., and William S. Galler.

Journal of the Water Pollution Control Federation, Vol 40, No 8, Part 2, p R303-R315, August 1968. 14 fig, 4 tab, 11 ref.

Descriptors: *Films, *Trickling filter, *Measurement, Biochemical oxygen demand, Waste water treatment, Filter, Biological treatment, Performance, Distribution, Efficiencies, Microorganisms, Sewage treatment.

Identifiers: *Neutron moderation, *Accumulation.

High energy or fast neutrons emitted from the nucleus of heavy atoms can be slowed down or

moderated by inelastic scattering and elastic scattering. Good moderators must be light in order to absorb larger amounts of energy per collision. The slimes formed in biological filters contain large amounts of water as well as carbon, nitrogen, and oxygen, which are all good moderators. Methods and instrument calibration are presented. The study conducted on a trickling filter at Raleigh, North Carolina showed that the amount of film present during the summer months is 50% less than that during the winter. The film was evenly distributed over the depth during the summer but a substantially larger film accumulated at the filter top during the winter. There was no correlation found between filter performance and weight of slime accumulation. A typical biomass distribution for a winter day showed for a depth of 1.5 feet 300 grams per cubic foot, and for a depth of 4.5 feet 235 grams per cubic foot. A typical summer day showed a biomass distribution of 115 grams per cubic foot throughout the depth. (Hancuff-Texas) W70-06895

AN IMPROVED TOOL FOR MEASURING BIODEGRADABILITY,

Washington Univ., St. Louis, Mo.

R. H. F. Young, D. W. Ryckman, and J. C. Buzzell, Jr.

Journal of the Water Pollution Control Federation, Vol 40, No 8, Part 2, p R354-R368, August 1968. 9 fig, 4 tab, 16 ref.

Descriptors: *Biodegradation, *Organics, *Biochemical oxygen demand, *Carbon, Laboratory test, Chemical oxygen demand, Nitrogen, Nitrification, Chemical degradation, Measurement, Oxidation, Respiration.

Identifiers: *Total organic carbon, Growth.

The system was designed to provide the rate, degree of biodegradation and the influence of organic compounds on aquatic life. The technique involved measurement of microbial respiration as determined by oxygen utilization, chemical oxygen demand, total organic carbon, measurement of bacterial growth and bioassays of unit effluent. The recommended period of study is 20 days and the chemical concentration is 10 mg/l. To test the general applicability of the method, twenty organic chemicals were studied, varying in structure, composition, biochemical behavior and toxicity. A good indicator of the fate of organic carbon removed from solution during biodegradation was the ratio of respiratory carbon to synthesis carbon. The onset of nitrification in the system can be identified rapidly by use of the colorimetric method measurement of nitrite. This measurement helps to differentiate between the carbonaceous and the nitrogenous oxygen demand. (Hancuff-Texas) W70-06896

AERATION SWEETENS HARBOR BASIN IN LOS ANGELES,

Pomeroy, Johnston and Bailey, Pasadena, Calif.

Henry Cruse.

Water and Pollution Control, Vol 108, No 4, p 42-44, April 1970. 1 fig.

Descriptors: *Aeration, *Waste water disposal, *Industrial waste, *Dissolved oxygen, Waste treatment, Performance, Biochemical Oxygen Demand, Costs.

Identifiers: *Los Angeles harbor, *Vegetable oil products.

A vegetable oil refinery is discharging about 10,000 pounds of BOD per day to slip number 5 in the Los Angeles harbor. This, along with an estimated 14,000 pounds of BOD per tidal change caused a pollution problem. In 1968 a wider program of water quality control was enforced and it was necessary to provide treatment. The cost of on-site BOD treatment was prohibitive, on the order of a quarter of a million dollars, and forced main pumping to the nearest treatment plant would cost \$420,000 for construction and \$40,000 annually. Finally it was decided to treat the entire body of

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polluted water. The avoidance of navigational problems eliminated the use of a surface aerator and a novel air diffuser had to be used. The air diffuser is anchored to the bottom of the body of water and is held erect by the vertical flow of air. When the air flow is shut off the diffuser will sink to the bottom and thus allow ships to pass over. Not the least of the considerations was the estimated cost of \$130,000 capital cost, and \$20,000 annual cost, very much lower than the other methods considered. Slip number 5 showed an unequivocal and marked improvement. This achievement was found to be due to two different effects exerted by the system. First, it acted as a mixing device increasing the dilution factor ten fold, and second, it increased supply of dissolved oxygen in the order of 1 lb oxygen per horsepower hour. (Hancuff-Texas)
W70-06897

CHEMICAL PRECIPITATION OF PHOSPHORUS IN A HIGH-RATE ACTIVATED SLUDGE SYSTEM,
Pennsylvania State Univ., University Park.
William A. Eberhardt, and John B. Nesbitt.
Journal of the Water Pollution Control Federation, Vol 40, No 7, p 1239-1269, July 1968. 13 fig, 20 tab, 47 ref.

Descriptors: *Activated sludge, *Phosphorus, *Chemical precipitation, Domestic wastes, Waste water treatment, Sewage treatment, Biochemical Oxygen Demand, Efficiency, Performance.

A biological-chemical process utilizing high-rate activated sludge system offers high BOD removals as well as high phosphorus removals. In a laboratory scale pilot study, both synthetic and domestic waste water were used under completely mixed conditions. A 60 liter per day waste was treated with an aeration time of 2.7 hours including the air-agitated chemical mixing basin. Solids that were separated in a clarifier were returned to the aeration basin and excess sludge was wasted semicontinuously. Aluminum sulfate was added to the mixed liquor to precipitate the phosphorus. The precipitate is settled, returned and wasted with the sludge. The system produced effluent residuals of less than 2 Mg PO₄/l unfiltered, and 0.05 mg PO₄/l filtered total phosphate and 20 mg/l BOD₅. Influent measurements were 39.1 mg phosphorus/l, 260 mg BOD₅/l, and loading of 146 lb BOD/d/1000 cu.ft. Aluminum sulphate dosage requirement for this result was 335 mg/l. (Hancuff-Texas)
W70-06898

FUNCTION OF SOLIDS IN ANAEROBIC LAGOON TREATMENT OF WASTE WATER,
Melbourne Water Science Inst. (Australia).
C. D. Parker, and G. P. Skerry.
Journal of the Water Pollution Control Federation, Vol 40, No 2, p 192-204, February, 1968. 13 tab, 4 ref.

Descriptors: *Anaerobic conditions, *Efficiencies, *Lagoons, *Sludge, Algae, Biochemical Oxygen Demand, Mixing, Sewage treatment, Waste water treatment.
Identifiers: *Anaerobic treatment, *Australia, Laboratory-scale studies, Plant-scale studies, Removal.

Field studies of anaerobic lagoons in Australia have shown that solids farther from the inlet of a lagoon are more active in purification than those deposited closer to the inlet, although in many cases they show lower gas yields. Lagoon sludge purification index (Lbs BOD/acre/day/lb VS) values ranged from 0.0053 during the winter at a typical pond inlet to 0.00902 during the summer at the pond outlet. The organic load to the pond during this period was about 482 lbs BOD/day/acre, and the sludge gas yield varied from 1.2 to 7.7 ml/day/gVS. The presence of algae in pond supernatant apparently does not reduce the sludge's BOD removal capacity. Where methane fermentation is inhibited, BOD can still be removed by sulfate reduction.

Laboratory studies showed that a substantial increase (almost 30%) in BOD removal can be achieved by mixing sludge with the supernatant, and that algae proliferate readily in media with high organic contents. (Aguirre-Texas)
W70-06899

LIFE AND HEALTH ASSURANCE,
Westchester County Dept. of Public Works, N.Y.
Guy E. Griffin.
Journal of the Water Pollution Control Federation, Vol 40, No 7, p 1292-1297, July 1968. 6 fig, 3 ref.

Descriptors: *Safety, *Management, Waste treatment, Accidents, Costs, Operation and maintenance, Sewage treatment.

Identifiers: *Injury frequency rate, Collection, Responsibility.

Recent data indicating treatment plant accident rate are cited as being 7 times greater than that for 41 major industries. Several specific examples of poor safety practice are cited; for example, low level bridges where skulls are cracked and electrical fixtures in explosive areas near digesters. Design, operation and maintenance all play vital roles in achieving a good safety program. A well-constructed safety program is an important and necessary part of any facility in order to prevent a loss of life, injury, and to keep loss of work time at a minimum. Dangerous accidents can be avoided by employing a well-designed, strictly enforced safety program. Recent awareness of the problem will improve the safety outlook. (Hancuff-Texas)
W70-06900

SURVIVAL OF HUMAN PATHOGENS IN COMPOSTED SEWAGE,
Utah Univ., Salt Lake City.
B. Beauford Wiley, and Stephen C. Westerberg.
Applied Microbiology, Vol 18, No 6, p 994-1001, December 1969. 1 fig, 3 tab, 17 ref.

Descriptors: *Sewage, *Pathogenic bacteria, *Bacteria, Salmonella, Fungi, Viruses, Sludge, Thermophilic bacteria, Isolation.

Identifiers: *Survival, *Composting, *Thermosensitivity, Thermo-death time, Thermo-death point.

When sewage sludge is composted it is vitally important that the composting process be operated in such a way as to insure thermophilic bacteria activity. This bacterial activity is necessary to produce sufficiently high temperatures over an adequate period to render the composted product free from pathogenic organisms. Experiments conducted in this study were designed to determine if pathogens could possibly survive thermophilic temperatures present during composting. This was achieved by introducing indicator organisms into a composter and periodically testing for their survival. The composter fulfilled the requirements of thermophilic activity and maintained a temperature range within the compost from 60-70 deg C. The indicator organisms which were assumed representative pathogens were: Salmonella newport as typical bacteria, Polio virus Type I as virus, Aschris lumbrocoidea as metazoan parasite, and Candida albicans as fungus. Survival times at 60 deg C were determined to be 40 minutes, 5 minutes and 60 minutes for the first three, and 60 minutes at 70 deg C for C. albicans. It was shown that composting performed in this experiment (5 days at 60 - 75 deg C) was sufficient to destroy all indicator organisms. (Hancuff-Texas)
W70-06901

SALMONELLA IN WASTES PRODUCED AT COMMERCIAL POULTRY FARMS,
Rutgers - The State Univ., New Brunswick, N.J.
D. J. Kraft, Carolyn Olechowski-Gerhardt, J. Berkowitz, and M. S. Finstein.
Applied Microbiology, Vol 18, No 5, p 703-707, November 1969. 4 tab, 13 ref.

Descriptors: *Salmonella, *Poultry, Bacteria, Sampling, Pathogenic bacteria, Waste disposal, Farm wastes.

The potential of poultry excreta and manure from commercial farms to contaminate the environment with salmonella was determined. Composite samples of freshly voided excreta from 91 poultry houses were tested qualitatively for salmonella. Twenty-six (29%) were positive. Of the 36 farms tested, 18 showed positive samples. In a separate quantitative study salmonella densities ranged from less than 1 to over 34,000 per gram excreta (dry weight). Those samples from floor and caged birds were comparable with respect to the incidence of salmonella. As shown in a qualitative survey there were distinct differences. High densities of the pathogens were found in fresh excreta from caged but not floor birds. It is concluded that the spreading of these wastes could have disseminated substantial numbers of salmonella onto the soil possibly lending to the contamination of water via surface run-off. It is suggested that the recently developed plow-furrow-cover method of manure application may be advantageous in burying the waste thereby preventing its transport by surface run-off. (Hancuff-Texas)
W70-06902

DIVISION OF COST RESPONSIBILITY FOR WASTE WATER SYSTEMS,
Brookings Institution, Washington, D.C.; and Federal Water Pollution Control Administration, Washington, D.C.

James A. Johnson.
Journal of the Water Pollution Control Federation, Vol 42, No 3, p 341-353, March 1970. 1 tab, 9 ref.

Descriptors: *Cost, *Sewer, *Waste disposal, Waste water treatment, Allotment, Economics, Expenditures, Sewage disposal, Sewage treatment.

Identifiers: *Revenues, Equity, Responsibility, Authorities.

Cost of waste water collection and treatment systems are high and are likely to remain so because of emphasis on high water quality. They are met by a combination of general revenue, special assessments, service charges and grants; because costs are high it is important that they be allocated fairly among users, property owners, and the general public. A number of formulas, namely, Public utilities, differential benefits, historical, added expenditure, alternative revenue, capital and operating cost, relative use, and Joint Committee formulas have been proposed for the cost allocation. These vary greatly in the burden assigned to each group. Consideration of the nature of waste water service, benefits received by groups within society and responsibility of disposing of waste govern the allocation. (Hancuff-Texas)
W70-06903

USE OF CLARIFYING AGENTS FOR PURIFYING WASTE WATERS FROM RAYON PRODUCTION (IN RUSSIAN),
V. A. Mal'kov.
Vodosnabzh Sanitarna Technika, No 1, p 7-11, 1968.

Descriptors: *Analytical techniques, Iron compounds, Textiles, *Waste water treatment, *Fibers (Plant), Hydrogen sulfide.

Identifiers: *Rayon manufacturing plant, Rayon, Zinc compounds, Zinc ions, Sulfuric acid, Clarification.

Waste waters from rayon production contain H₂SO₄ 21-2000, zinc-ion 10-150, iron calcium hydroxide, and suspended material 27-300 mg/l, (pH 1.7-2.8). Preliminary clarification by liming with 3-5% iron calcium hydroxide was very satisfactory, and the most efficient continuous clarifier was the slot type. At a settling rate of 1.4 mm./sec. 89% of the deposit could be removed and 87% of the zinc removed (zinc sulfate was converted to insoluble zinc hydroxide at pH 9.5-11).

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

The treated wastes then contained suspension of 56 and zinc of 4.6 mg/l. At a settling rate of 0.4-0.5 mm./sec. somewhat better results were obtained. The sludge carried off had 98-9% moisture, and the dry deposit averaged 3-4% of the waste volume. (Work-North Carolina State Univ) W70-06904

PUBLIC RELATIONS—A SELF-ANALYSIS,

Iowa Univ., Iowa City.

Lane H. Mashaw.

Journal of the Water Pollution Control Federation, Vol 42, No 3, p 354-360, March 1970. 3 tab, 4 ref.

Descriptors: *Management, *Waste water treatment, Analysis, Surveys, Education, Government, *Attitudes.

Identifiers: *Operator, *Questionnaires, *Public relations, Associations, Opinions, Certification, Iowa.

A questionnaire was developed and mailed to 450 treatment plant operators to provide data on existing attitudes and activities in public relations upon the waste water treatment plant personnel in the state of Iowa. The results were divided into three groupings, those serving less than 1000 population, those serving between 1000 and 5000 and those serving more than 5000 population. The data sought were limited to three general headings: (1) How do my superiors view me. (2) How do I feel about my job. (3) Am I public relations oriented. The results of this study tend to confirm a long-standing contention that waste water treatment facility operators are among the most conscientious of employees, public or private. Their attitude towards public relations is very good and their concerted effort to attain good public relations is very bad. Recommendations are offered to the member associations of the Water Pollution Control Federation to be more active in training the operators in public relations tools and in fostering recognition of achievement by the operators. (Hancuff-Texas)

W70-06905

GREEN BAY, WISCONSIN-JOINT TREATMENT OF PULP MILL AND MUNICIPAL WASTES,

Charmin Paper Products Co., Green Bay, Wis.; and Green Bay Metropolitan Sewage District, Wis. C. R. Faulkender, J. F. Byrd, and David W. Martin. Journal of the Water Pollution Control Federation, Vol 42, No 3, p 361-370, March 1970. 7 fig.

Descriptors: *Pulp and paper industry, *Trickling filter, *Municipal waste, *Waste water treatment, Sewage treatment, Industrial waste, Pilot plant, Waste treatment, Biochemical Oxygen Demand, Activated sludge, Pulp wastes.

Identifiers: *Combined treatment, Green Bay (Wis), Contact stabilization, Krauss process, Yeast treatment.

Development of the waste treatment processes at the Charmin Paper Mill Plant is given, beginning with a yeast plant constructed in 1955 which was designed to remove 45-50% BOD. In 1957 further reduction in BOD was required by the state. A multiple effect evaporator concentrates the yeast plant effluent from 10 to 12% solids range to 55-60% range. At this concentration the material can be atomized into specially designed boilers where organic materials are burned. The combined facilities yeast plant evaporation and burning reduced the overall effluent BOD from pulping to more than 70%, an amount of 140,000 pounds of BOD. For further reduction in BOD, a laboratory and pilot-plant study was made. The study was made to determine the feasibility of combining the municipal waste with the industrial waste. Individual units were fed: (1) municipal waste, (2) industrial waste, (3) combined waste with nutrient addition, and (4) combined waste without nutrient addition. The industrial waste was adjusted to a pH of 6.5 - 7.5. The investigation demonstrated that Charmin waste was amenable to treatment in combination

with municipal waste at the volume ratio of 1:20 and a BOD ratio of 1:1. Present research program is studying the operation parameters of four different continuous flow biological processes for combined treatment of municipal waste and dilute waste from the pulping process. The types are: (1) conventional, (2) contact stabilization, (3) separation, and (4) Krauss. (Hancuff-Texas) W70-06906

POLLUTION CONTROL - FEEDLOT OPERATIONS,

Iowa State Univ., Ames.

J. R. Miner, E. R. Baumann, T. L. Willrich, and T. E. Hazen.

Journal of the Water Pollution Control Federation, Vol 42, No 3, p 391-398, March 1970. 1 tab, 6 ref.

Descriptors: *Livestock, *Pollution abatement, Waste disposal, Reservoirs, Waste treatment, Cattle, Sewage treatment, Farm wastes, Iowa, Hogs, Poultry.

Identifiers: *Feedlot, Population equivalent.

The increase in labor cost and a shortage of personnel has caused an increase in feedlot population. The result has been a concentration of livestock waste level. Techniques of feedlot waste systems design are reported, and methods of collecting and disposing of the waste are discussed. These cattle, swine, and poultry feedlot operations are similar. Types of flooring and methods of cleaning are discussed. Treatment and disposal of the waste are commented on, including tank storage and hauling, anaerobic lagoons, aerobic lagoons, surface irrigation systems and oxidation ditches. The limiting factors of various treatments in relation to feedlot waste are reported. Zoning regulations are suggested as a partial solution to nuisance complaints which are generated by concentration of livestock in feedlots. (Hancuff-Texas)

W70-06907

WASTE WATER TREATMENT AND RENOVATION STATUS OF PROCESS DEVELOPMENT,

Federal Water Pollution Control Administration, Washington, D.C.

David G. Stephan, and Robert B. Schaffer.

Journal of the Water Pollution Control Federation, Vol 42, No 3, p 399-410, March 1970. 1 tab, 1 ref.

Descriptors: *Waste water treatment, *Water reuse, *Research and development, *Grants, Pilot plants, Operational costs, Capital costs, Costs.

Identifiers: *Advance waste treatment, Development, Carbon adsorption, Nutrient removal, Renovation, Physical-chemical treatment, Suspended solids removal.

The advanced waste water treatment technology being developed and studied in the United States at the current time is tabulated. Over 350 studies in 95 categories of advanced waste treatment are listed. Some of the processes, although studied many years ago, have found renewed promise due to scientific breakthrough. Others, such as ultrafiltration, electro-osmosis, and plasma arc are indicative of the developing technology of the waste water treatment field. The study of modified activated sludge has increased more than three fold in two years. Advances have been seen since 1967 with the use of activated carbon and the number of projects on nutrient removal has doubled in two years. The independent physical-chemical treatment process, under study at several locations, is discussed extensively. Included in the tabulation are the treatment processes, scale, and location. (Hancuff-Texas)

W70-06908

EFFECT OF OXYGEN-TRANSFER CAPABILITIES ON WASTE WATER TREATMENT PLANT PERFORMANCE,

Milwaukee Sewerage Commission, Milwaukee, Wis.; and Rex Chainbelt, Inc., Milwaukee, Wis.

Raymond D. Leary, Lawrence A. Ernest, and William J. Katz.

Journal of the Water Pollution Control Federation, Vol 40, No 7, p 1298-1310, July 1968. 13 fig, 4 tab, 4 ref.

Descriptors: *Deficiency, *Aeration, Dissolved oxygen, Waste water treatment, Activated sludge, Performance, Biochemical Oxygen Demand, Diffusion, Mass transfer, Oxygen, Sewage treatment.

Identifiers: *Oxygen transfer, Layout.

Two activated sludge treatment plants at Milwaukee, Wisconsin were run in parallel. Marked changes in performance occurred when changes were made in the aeration systems. One of the systems was converted from a spiral flow plate diffusion system to a tapered aeration spiral flow ceramic diffuser system. The efficiency declined rapidly in spite of the diversion of part of the load to the other plant. BOD in the effluent went from 15 mg/l to between 40 and 50 mg/l. In addition, wasting of the sludge from the ailing plant to the return sludge of the other plant lowered the latter's efficiency until this practice was discontinued. A study of several diffusion patterns for oxygen transfer efficiencies showed that the spiral flow aeration basin had the lowest oxygen transfer efficiency and the ridge and furrow system the highest. The low efficiency plant improved its performance when diffuser plates were installed in a longitudinal pattern. (Hancuff-Texas)

W70-06909

TREATMENT OF COMBINED KRAFT AND NEWSPRINT EFFLUENTS AT AN ALABAMA PAPER MILL,

Kimberly-Clark Corp., Coosa Pines, Ala. Coosa River Newsprint Div.

B. J. Cottle, Jr., H. Newbauer, J. Buck, and R. M. Billings.

Journal of the Water Pollution Control Federation, Vol 40, No 7, p 1314-1331, July 1968. 10 fig, 7 tab, 2 ref.

Descriptors: *Industrial wastes, *Lagoon, Cost, Biochemical Oxygen Demand, Dams, Settling basins, Sewage treatment, Sludge, Pulp wastes, *Pulp and paper industry.

Identifiers: *Paper making, Thickening.

The oxygen content of water supplied to the paper mill on the Coosa river, Alabama will be greatly reduced when construction of a power dam is completed. Also, the raising of the height of a dam downstream will reduce the reaeration capabilities of the receiving waters. A 274 foot diameter primary clarifier, and 370 acre final lagoon were added to the existing facilities (a conventional lagoon system) and will permit removal of 97% of the effluent suspended solids, and 35% and 78% of the BOD in winter and summer respectively. The sludge is thickened from 5% to 18% through the use of centrifuges. The construction of under water weirs above the two upstream dams have increased the dissolved oxygen in the water supplied to the mill. The final lagoon allows release to the river to be coordinated with the river flows. The river requirements are such that a minimum of 4 mg/l DO is to be maintained. Capital cost of the treatment is approximately 2.5 million dollars, operating costs about \$125,000 per year. (Hancuff-Texas)

W70-06910

1967 STATUS OF OPERATOR TRAINING AND CERTIFICATION IN THE UNITED STATES.

Water Pollution Control Federation, Washington, D.C.

Journal of the Water Pollution Control Federation, Vol 40, No 7, p 1332-1337, July 1968. 2 tab.

Descriptors: *Survey, Waste water treatment, Treatment facilities, *Training, Permits.

Identifiers: *Certification, Operator training.

Two tables are presented reporting the 1967 status of waste water treatment plant operator training and certification in the United States. The first

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table presents the state, program and level, text used, sponsors and conducting group, attendance at the latest course, fee for the course and remarks. The second table presents the status of operators certification. Tabulated are state, type of certification and date adopted, number of operator grades, number of operators certified, number of plants in state, plants with certified operators, and remarks. (Hancuff-Texas)
W70-06911

CONCENTRATION OF VIRUSES FROM SEWAGE AND EXCRETA ON INSOLUBLE POLYELECTROLYTES,
Baylor Univ., Houston, Tex. Coll. of Medicine.
For primary bibliographic entry see Field 05A.
W70-06912

TRACE ELEMENTS AND THEIR ORIGIN IN A METROPOLITAN WASTE WATER EFFLUENT,
For primary bibliographic entry see Field 05A.
W70-06915

CHICAGO'S SOUTH WATER FILTRATION PLANT.

Chicago, Department of Water and Sewers and Department of Public Works, 1968, 9 p, 15 fig.

Descriptors: *Water treatment, *Water purification, *Filtration, *Filters, *Water supply, *Water works, *Treatment facilities, *Construction, Operations.

Identifiers: *Chicago Water Department.

This pamphlet is a brief, yet complete, overview of Chicago's expanded South Water Filtration Plant located at Lake Michigan near 79th Street. The plant is the second largest in the world, being exceeded in capacity only by its sister Central Water Filtration Plant near Navy Pier. The South Plant, placed in operation in 1947 with a rated capacity of 320 mgd, was expanded during the period 1961-1967 to a rated capacity of 480 mgd with a capability, if required, of 850 mgd. It now serves 1,900,000 persons. The major improvements included adding: 2 settling basins, making a total of 5; 40 sand filters, making a total of 120; 2 filtered water basins, making a total of 6, and one 150 mgd pump. Chemical storage facilities were increased to facilitate increased dosages of carbon and chlorine necessitated by the deterioration of the (Lake Michigan) raw water supply during recent years. The chemicals are used to achieve water stabilization to minimize corrosion and mineral deposits in pipes, as well as for combatting water pollution. The South Plant expansion program cost approximately \$12 million, financed from water revenues. A flow diagram, photographs, and discussion of the plant and operations are included. (Poertner-Chicago)
W70-06919

MANAGEMENT OF POLLUTION DATA USING MODERN TECHNIQUES,

Minneapolis-St. Paul Sanitary District, Minneapolis, Minn.

Robert L. Callery.

Paper presented at the Annual and Environmental Meeting of the American Society of Civil Engineers, Chicago, October 15, 1969. 18 p, 8 ref. FWPCA Facilities Demonstration Grant No. I-Minn.-1.

Descriptors: *Data collection, *Data processing, *Data storage and retrieval, *Automation, *Instrumentation, *Remote control, *Computers, *Control systems, *Data transmission, *Telemetry, *Analytical techniques, *Regulated flow, *Remote sensing, *Flow control, *Sewers, Outlets, Urbanization, Monitoring.
Identifiers: *Minneapolis-St. Paul Sanitary District, *Overflow regulators.

Modern techniques being used by the Minneapolis-St. Paul Sanitary District in a project involving acquisition and management of water pollution data are described. The project was initiated to develop a system for remote dispatching of combined-sewer flows through the interceptor sewers in the Minneapolis-St. Paul area, and to improve the performance of sewer overflow regulators. Real-time water quality data are transmitted automatically by leased telephone wires, from transducers located at stations on the Mississippi River to a central station. Depth measurements and overflow regulator gate positions in trunk sewers and in the interceptor sewer system, together with readings from 9 rain gages, can be logged automatically in a central station, at almost any frequency desired. Analog signals, after being converted to digital form, are presented to the processor for logging—or analysis, tabulation, correlation, or outputting. Programs supplied by the Sanitary District can scan and log, separately, each of four different reports: (1) River Quality Monitor report, (2) Overflow Regulator report, (3) Interceptor report and (4) Rain report. The use of the STORET System, in-plant data logging, and automatic analysis of sewage quality using the Technicon Auto-Analyzer are described. (Poertner-Chicago)
W70-06922

CHICAGO WATER SYSTEM, A DESCRIPTION OF THE SYSTEM AND ITS SANITARY PROTECTION.

City of Chicago Department of Water and Sewers, November 1966. 30 p, 8 fig, 3 tab.

Descriptors: *Water supply, *Water delivery, *Water distribution, *Water management, *Water structure, *Water works, *Waste water treatment, *Water purification, *Filtration, *Treatment facilities, *Distribution systems, Water costs, Construction, History, Construction costs, Operating costs, Urbanization.
Identifiers: *Chicago.

This pamphlet describes Chicago's water system and its sanitary protection. In the early days of settlement, Chicago dwellers drew their water supply directly from the Chicago River and Lake Michigan. As the population served grew from 178,500 at the end of the Civil War to its present 4.6 million in the metropolitan area of 402 square miles, the rivers and lakes have been polluted and vast networks of pumps, pipes, sewers and treatment plants had to be constructed to meet the demands of the people and industry. Thus, Chicago had developed and is operating one of the world's largest water supply systems. Water is now obtained from Lake Michigan through two of four intake cribs located two to three miles offshore, and one shore intake at each of the two filtration plants. Ten pumping stations, each having 5 pumps, deliver more than one billion gallons per day through 4,083 miles of pipes. The newer and larger of Chicago's two filtration plants is the Central Plant which is capable of producing treated water at a rate of 1.7 billion gallons per day. It went into operation in 1964 and became, by far, the largest water treatment plant in the world. The South Plant, built in 1947, is the second largest plant in the world. Cost to the consumer is five cents per ton of water. This is the cheapest rate of all the major cities in the United States. (Poertner-Chicago)
W70-06923

MAIN STATION CONTROL,
Louisville Water Co., Ky.
For primary bibliographic entry see Field 08C.
W70-06924

USE OF UNICELLULAR ALGAE FOR PURIFYING WASTE WATERS FROM MAN-MADE FIBER PLANTS (IN RUSSIAN),
G. M. P. Mordvintseva, V. V. Grabovskaya, and V. K. Marinich.
Khimicheskie Volokna, Vol. 3, p 61-62, 1966.

Descriptors: *Algae, Iron compounds, Hydrogen sulfide, Biochemical Oxygen Demand, Nutrients, Waste water treatment, *Fiber (Plant).
Identifiers: *Viscose rayon plant wastes, *Man-made fiber plants, Nylon-6, *Viscose Rayon, Zinc compounds, Carbon disulfide.

Laboratory and pilot-plant experiments are reported on the use of unicellular green algae (*Chlorella* and *Ankistrodesmus*) to treat waste waters from the manufacture of nylon-6 and viscose rayon. Growth of the algae could be stimulated by addition of nutrients such as urea, magnesium sulphate, and potassium phosphate. It was found that treatment, which was complete within 6 days under laboratory conditions and 3 days in the open air, effected complete removal of zinc, iron, hydrogen sulphide, carbon disulphide, and sulphides, reduced the BOD by 90 percent, and increased the dissolved-oxygen concentration by 100-400 per cent, but had no effect on calcium and sulphates. (Livengood - Work-North Carolina State Univ)
W70-06925

CHICAGO'S CENTRAL WATER FILTRATION PLANT.

Department of Water and Sewers, Chicago, Ill.; and Department of Public Works, Chicago, Ill.
For primary bibliographic entry see Field 08C.
W70-06927

ARE WE OR ARE WE NOT GOING TO CLEAN UP,

Metropolitan Sanitary District of Greater Chicago, Ill.

Vinton W. Bacon.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 354-367, 30 fig.

Descriptors: *Water quality control, *Flood control, *Lake Michigan, *Sewage disposal, Air pollution, *Fertilization, *Inland waterways, *Monitoring, *Tertiary treatment, Tunneling, Chlorination, Water sources.

Identifiers: *Sanitary District of Chicago, *Deep Tunnel Plan, *Combined sewage system, Stream cleaning, Microstraining.

Chicago efforts to improve water quality are outlined beginning in 1891 with the formation of the Sanitary District and the subsequent reversing of the Chicago River up to recent plans for sludge use and the deep tunnel project. Capacities of the various treatment plants are outlined and problems resulting from sewer construction and fertilizer drying operations discussed. The sanitary district is described as a wholesaler of sewage since it does not construct the local sewerage system. Improvements in construction of large sewage installations include tunneling because of its less disruptive effect on communities. Flood control with the Melvin Reservoir and plans for additional reservoirs are outlined along with plans for reduction of spillage to the lake with the deep tunnel project. The Ten-Year Program to upgrade waterways with chlorination facilities and tertiary treatment are suggested as ultimately allowing recreation involving full body contact, support of fish life, and service as a municipal water source. In addition to tertiary treatment, microstraining and an eleven-station monitoring system are suggested for improved waterways quality. Finally, means of disposing of the approximate one thousand tons per day of sludge are discussed. Costs of six alternative methods are presented along with limitations in disposal potentials of each. Because present methods account for approximately 40 per cent of the total operating budget and because use of sludge as fertilizer without drying could be considerably cheaper, special attention is directed toward its use in reclaiming farm lands and strip mines. (Preckwinkle-Chicago)
W70-06951

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5D—Waste Treatment Processes

REMOVAL OF LIGNIN BY FOAM SEPARATION PROCESSES,

Rutgers - The State Univ., New Brunswick, N.J.
Dept. of Civil Engineering.

T. E. Wilson, and M. H. Wang.

Paper, presented at the 25th Purdue Industrial Waste Conference, West LaFayette, Ind., May 6, 1970, 15 p., 3 fig, 4 tab, 11 ref. OWRR Project A-022-NJ.

Descriptors: *Lignin, *Foam separation, *Waste treatment, *Industrial waste treatment, Color, Water quality, Water quality control, Foam fractionation.

Identifiers: *Ion flotation.

Lignin is a compound difficult to remove from a waste water stream, and it appears to be the major source of color in natural waters. This paper reports on investigations into removing lignin by the process of foam separation. The method known as ion flotation achieved 98% removals of lignin on a color basis using cetyl or Arquad 2HT, over a wide concentration range. (Whipple-Rutgers)

W70-06955

THE ECONOMIC IMPACT OF DROUGHT ON WATER SUPPLY SYSTEMS IN THE PASSAIC RIVER BASIN, NEW JERSEY,

New Jersey Agricultural Experiment Station, New Brunswick.

A. Vaughn Havens.

Available from the Clearinghouse as PB-190 184, \$3.00 in paper copy, \$0.65 in microfiche. Report, December, 1969, 125 p, 19 tab, 31 fig, 41 ref. ESSA Grant WBG 86.

Descriptors: *Droughts, *Waste water treatment, *Costs, New Jersey, *Water supply, Water quality, *Economic impact, Evaluation, *Mathematical models, *Probability.

Identifiers: Drought probability, Passaic River basin.

The study was confined primarily to one adverse effect of the 1961-1966 drought for which good quantitative data were available. The Passaic Valley Water Commission supplies water to a densely populated and rather heavily industrialized section of northeastern New Jersey. The effect of the drought on water quality in the Passaic River at Little Falls and the subsequent effect on the water treatment costs of the Passaic Valley Water Commission are the principal subjects of this study. A closely related investigation of drought probability is also included in the final section of this report.

W70-06960

DILUTE SPENT KRAFT LIQUOR FILTRATION THROUGH WOOD CHIPS.

North Carolina State Univ., Raleigh. Dept. of Wood and Paper Science.

Available from the Clearinghouse as PB-191 873, \$3.00 in paper copy, \$0.65 in microfiche. Water Pollution Control Research Series report, April, 1970. 36 p, 9 tab, 4 fig, 3 ref, append. FWQA Program No. 12040 EUG.

Descriptors: Water pollution sources, *Waste water treatment, *Biochemical Oxygen Demand, *Pulp wastes, Pulp and paper industry, Industrial wastes, Effluents, Organic wastes.

Identifiers: *Kraft pulp mill, Biochemical Oxygen Demand-extraction, Wood chips, *Waste liquor.

The principal objective of this project was to determine if contact between effluent from a Kraft pulp mill and pine chips would reduce the water pollution characteristics of the waste liquor. The experimental work was divided into two phases: (1) a small scale laboratory investigation of contacting dilute waste liquor with chips; (2) a pilot-scale investigation of filtering waste liquor through a column and a pile of chips. It was found that contact of alkaline waste liquor, or even distilled water, with pine chips extracted organic matter from the

chips which had a considerable BOD₅. This extract corresponded to a pollution load of about 3-11 lbs. BOD₅ per ton of dry wood. Alkalinity, pH, and intensity of color of the waste liquor were somewhat reduced by the contact. These reductions are, however, too small to have any practical application in effluent treatment. It can, in general, be concluded that contact of alkaline waste liquor, or water, with wood chips extracts soluble organics and adds pol-lutional materials to the effluent stream.

W70-06961

SURPLUS PHOSPHORUS UPTAKE BY MICROORGANISMS-BATCH TESTS WITH DILUTE ACTIVATED SLUDGE CULTURES,

Texas Univ., Austin. Center for Research in Water Resources.

Harry G. Moore, Jr., E. Gus Fruh, and Robert B. Higgins.

Technical Report No. 2, EHE-69-08, CRWR-41, Feb 1969, 44 p, 12 fig, 5 tab, 33 ref. FWQA Grant WP-01449-01.

Descriptors: *Phosphorus, *Phosphates, *Activated sludge, *Enzymes, *Biological treatment, Nutrients, Waste water treatment, Sewage treatment.

Identifiers: Alkaline phosphatase, Phosphorus uptake, Orthophosphate, Phosphorus removal, P-nitrophenol phosphate.

An alkaline phosphatase assay based on the use of a P-nitrophenyl phosphate substrate was studied for its applicability to indicate 'surplus' phosphorus uptake by a dilute heterogeneous bacterial culture obtained from an activated sludge process. This investigation demonstrated the validity of the enzymatic bioassay using viable bacterial cells and determined conditions under which the bioassay should be conducted as a standard procedure. Alkaline phosphatase activity was found to be repressed by both orthophosphate external to the cells and by stored phosphorus within the bacterial cells. Based on these studies, the assay appears useful to help elucidate the mechanism responsible for the abnormally high phosphorus removal being attained by various activated sludge plants in the United States. The research also indicates the possible significance of the surplus phosphorus uptake phenomenon in waste treatment processes. (Makela-Texas)

W70-06964

POLYMERS IN WATER TREATMENT,

Union Carbide Corp. Chemical Div.

B. Mansfield.

Process Biochemistry, Vol 5, No 2, p 28-30, 1970. 4 fig, 3 tab, 6 ref.

Descriptors: *Oxides, *Fluid friction, Sewers, Slurries, Waste water treatment, Sludge treatment, Toxicity, Algae, Bacteria, Fish, Sewage sludge, Flow, Flocculation, Coagulation, Filtration, Viscosity.

Identifiers: *High-molecular-weight polymers, Turbulent frictional drag, Alkylene oxide, Polymerization, Ethylene oxide, Water clarification, Sludge drying, Polyethylene oxide polymers, Sewage settling, Union Carbide Corp., Polyox, Carbowax, Flocculant dosages, Baroco clay soils, Uranium ore.

The discovery and subsequent production by Union Carbide of high-molecular-weight polymers, such as Polyox, permits a reduction of surcharges in sewer pipelines. Injection of these polymers at concentrations of 45 to 200 ppm increases more than 100% the sewage flow, thereby eliminating the necessity of parallel pipes. The chemicals do not adversely influence bacteria or fish, or increase algal growth. They have no measurable biochemical oxygen demand, but improve sewage settling and sludge drying. Addition of the polymers to water-based slurry markedly decreases flow resistance. The polymers are highly effective agents for increasing settling and filtration rates of dispersed solids and facilitate water clarification. (Wilde-Wisconsin)

W70-06968

EXPERIENCES IN THE TREATMENT OF TEXTILE MILL WASTE WATERS ON A PERCOLATING FILTER (IN RUSSIAN),

J. Nosek, and V. Vondrik.

Voda, Vol. 32, p 226-228, 1953.

Descriptors: *Biochemical Oxygen Demand, Color, Filters, *Waste water treatment, *Textiles. Identifiers: *Textile mill wastes, *Coal slag, Dyehouse wastes, Dyestuffs, Percolating filters.

The waste waters from a dyeing, printing, and bleaching plant are treated successfully by filtration through a 1-m. layer of brown coal slag. The BOD is reduced by 35-45% and color is reduced by 80-90% and frequently completely removed. (Livengood-Work, North Carolina State University)

W70-06972

SLAG AS FILTER MATERIAL FOR TREATMENT OF TEXTILE MILL WASTE WATER (IN RUSSIAN),

J. Nosek, and V. Vondrik.

Voda, Vol 33, p 14-15, 1953.

Descriptors: *Operation and maintenance, Filters, *Filtration, *Waste water treatment, Textiles.

Identifiers: *Textile mill wastes, Slag filter.

Information is given on the operation and maintenance of the slag filter for the treatment of textile mill waste waters. The upper layer of medium, to a depth of about 20 cm., must be loosened every 14 days. (Livengood-Work, North Carolina State Univ)

W70-06973

MECHANISM OF RAPID FILTRATION IN A UNIFORM FILTER BED,

Georgia Inst. of Tech., Atlanta.

T. F. Craft, and G. G. Eichholz.

Water Resources Research, Vol 6, No 2, p 527-537, April 1970. 11 p, 6 fig, 3 tab, 11 ref. OWRR Project B-020-GA.

Descriptors: *Filtration, *Flow, *Porous media, *Tracers, Radioactivity techniques, Particle size, Particle shape, Porosity, Cesium, Filters, Tracking techniques, Tagging.

Identifiers: Vermiculite.

A radiotracer study was carried out using cesium-137 labeled vermiculite particles to study the pattern of removal in a deep sand filter under rapid flow conditions. Sized sand and anthracite were used as bed media, and suspended particles were sized between 1 and 120 microns. By comparing the activity ratios in the upper bed levels, curves were obtained relating the filter coefficient to particle size and bed pore sizes. By analyzing the curves in relation to the various theories proposed to account for filter action, it was shown that interstitial sieving was the dominant mechanism down to a nominal pore-particle ration of 4. Below this ratio, van der Waals forces were adequate to explain residual removal effects, and the effective range of those forces was calculated. (Knapp-USGS)

W70-06990

EFFLUENTS FROM DYEING AND FINISHING BATHS (IN FRENCH),

E. Peyron.

Teintex, Vol. 32, No. 6, p 410, 421-422 and 425, 1967.

Descriptors: *Effluents, *Flocculation, *Activated carbon, Aeration, Calcium chloride, Waste water treatment, Textiles.

Identifiers: *Dyehouse wastes, *Textile finishing plant wastes, *Effluent treatment, *Auto neutralization, Effluent combination, Equalization bath, Aluminum sulphate, Sodium silicate, Textile mill wastes, Dyehouse waste.

Waste Treatment Processes—Group 5D

The treatments of dyeing and desizing effluents used in the textile industry were discussed. The autoneutralization, pH regulation, flocculation, decolorization by carbon and decantation processes involved were described. The installation steps used for a textile printing plant were discussed. The various effluents were combined in an equilibration bath provided with a surface skimming device and an aeration system by compressed air. Flocculation is carried out by Al₂(SO₄)₃ and Na silicate in a special tank. CaCl₂ used for decolorization is distributed automatically and is controlled by a galvanometric device. (Mattox and Livengood-North Carolina State University)

W70-07018

TREATMENT OF WASTE WATERS OF THE TEXTILE WORKS HERMANN WINDEL G.M.B.H. IN WINDELSBLEICHE NEAR BIELEFELD (IN GERMAN).

F. E. Hess.

Wasser und Boden, Vol. 9 p 474-475, 1957.

Descriptors: *Irrigation, *Waste Water Treatment, Baffles, Aeration, Sedimentation, Lagoons, Textiles, *Fibers (Plant).

Identifiers: *Textile mill wastes, *Artificial rain, Dilution, Cascades.

As the dilution available for the waste waters of a textile factory at Windelsbleiche is small, the waste waters are treated by irrigation and an artificial rain after sedimentation for 8-10 hours. The area used for disposal is drained and the drains discharge into a pond with a retention time of about 3 days from which the effluent flows to the stream. Baffles and cascades at the inlet and outlet of the pond ensure intensive aeration. Efforts are being made to reduce the load on the land and improve results by separate preliminary treatment of waste waters from different processes. (Livengood and Robinson - North Carolina State University)

W70-07020

PHOSPHATE REMOVAL: SUMMARY OF PAPERS,

FMC Corp., Panorama City, Calif. Water Pollution Div.; and FMC Corp., Chicago, Ill. Pump Div.

Milton Spiegel, and Tom H. Forrest.

ASCE Proceedings, Journal of the Sanitary Engineering Division, Vol 95, No 8A5, Paper 6807, p 803-815, October 1969. 13 p, 16 ref.

Descriptors: *Waste water treatment, *Phosphates, *Reviews, Tertiary treatment, Water pollution control, Phosphorus, Activated sludge, Sewage treatment, Waste disposal, Eutrophication, Bibliographies.

Identifiers: Phosphate removal.

Summaries are given of 16 papers presented at a Federal Water Pollution Control Administration Conference on Phosphorus Removal from wastewater at Chicago in June, 1968. These summaries are of processes comprising chemical precipitation, employing lime or alum and various means for solids separation; activated sludge removal; reverse osmosis; metallic salts and polyelectrolytes; activated bentonite compound; and activated algae. (Knapp-USGS)

W70-07021

ACID PROTECTION AND EFFLUENT TREATMENT IN THE TEXTILE INDUSTRY (In German),

W. Heyemann, and H. J. Bradke.

Spinner Weber Textilver, Vol. 84, No. 8, p 850-857, 1966.

Descriptors: Waste water treatment, *Textiles, Fibers (Plant), *Effluents.

Identifiers: *Acid protection, *Acid resistant tiles, Polyisobutylene, Bitumen, Effluent treatment tanks.

Special treatments to prevent attack by acid on floors of workshops are described; films of polyisobutylene offer short-term protection but bitumen or acid-resistant tiles are needed for permanent protection. A short survey of small-scale effluent treatment tanks is given. (Livengood and Robinson - North Carolina State University)

W70-07025

NITRIFICATION AND DENITRIFICATION IN A MODEL WASTE STABILIZATION POND,

Texas Univ., Austin. Center for Research in Water Resources.

Jorge Aguirre, and Earnest F. Glynna.

Environmental Health Engineering Research Laboratory, Report EHE-05-6701, CRWR-19, June 1967. 82 p, 22 fig, 5 tab, 38 ref. FWQA Contract WP-00688-38.

Descriptors: *Denitrification, Efficiencies, *Nitrification, Nitrogen compounds, Nitrogen cycle, Algae, Biological treatment, Bottom sediments, Nutrients, *Waste water treatment, *Oxidation lagoons, Milk, *Model studies.

Identifiers: *Facultative lagoons, Laboratory model, COD removal, Milk substrate, Nitrogen removal, *Milk wastes.

A laboratory model of a facultative waste stabilization pond was used to investigate nitrification and denitrification of milk wastes as a function of depth. The model was operated on a semi-continuous flow basis using a dry milk product as feed. The organic and hydraulic loading were kept constant at 50 lb BOD₅/acre/day and 3 inches/day (5 gal/d), respectively. General pond characteristics were evaluated by measuring D.O., pH, ORP and temperature profiles; COD and the different forms of nitrogen were monitored at frequent intervals during the test period to determine depth profiles of these parameters as well COD removal efficiencies and nitrogen transporations. A rapid removal of organics occurred in or near the bottom sediment layer with a correspondingly high degree of ammonification. Above the sludge layer the contents remained essentially unchanged except for minor variations due to algal density fluctuations. Detectable concentrations of nitrates were not found during the test period, but a substantial amount of nitrogen was lost from the liquid fraction. COD and nitrogen removals from the waste water, as measured by the overflow, were 85% and 44% respectively. (Aguirre-Texas)

W70-07031

RESPONSE OF ACTIVATED SLUDGE ON TRANSIENT LOADING,

Texas Univ., Austin. Center for Research in Water Resources.

Carl E. Adams, and W. Wesley Eckefelder, Jr.

Environmental Health Engineering Research Laboratory, Report EHE-69-04, CRWR-37, January 1969. 260 p, 51 fig, 26 tab, 46 ref.

Descriptors: *Activated sludge, *Kinetics, *Organic loading, Biochemical oxygen demand, Chemical oxygen demand, *Waste water treatment.

Identifiers: *Transient loadings, Laboratory studies, Oxygen uptake, Steady state, Substrate removal, Total organic carbon.

This study evaluates the acute and chronic effects of organic loading of a given waste on activated sludge systems under steady state conditions and compares these responses to the results obtained from transient studies using average organic loadings. Also examined were conventional substrate removal and oxygen uptake kinetic models, previously justified for steady state use, to determine if they could be employed to predict system responses under transient loadings. Three different wastes were used, synthetic, an industrial, and a domestic waste water. Each study consisted, generally, of a steady state phase and several transient phases in which both the magnitude and the duration of shock loading were varied. Conven-

tional kinetic models expressing the substrate removal rate as a function of growth-limiting substrate remaining in solution and predicting the oxygen requirements were shown to apply satisfactorily to both steady state and transient state conditions of the activated sludge process. It was demonstrated that systems can tolerate applied transients, up to three times the normal loading for 12 hours per day, for several days without showing any significant increase of effluent soluble organic matter. (Aguirre-Texas)

W70-07032

RELATIONSHIPS BETWEEN SELECTED PHYSICAL PARAMETERS AND COST RESPONSES FOR THE DEEP-WELL DISPOSAL OF AQUEOUS INDUSTRIAL WASTES,

Texas Univ., Austin. Center for Research in Water Resources.

Joe Clifton Moseley, II, and Joseph F. Malina, Jr. Environmental Health Engineering Research Laboratory Report EHE-07-6801, CRWR-28, August 1968. 276 p, 51 fig, 13 tab, 175 ref. Public Health Service Grant EH-68-610-B.

Descriptors: *Computer models, *Cost analysis, *Economic prediction, *Injection wells, Equations, Performance, Ultimate disposal, *Waste water disposal, *Industrial wastes.

Identifiers: Aqueous wastes, Computerized design, Economic data.

The objectives of this investigation were: (a) to develop the equations and the systems of equations governing the performance of an injection well, (b) to collect economic data on the components of such a system, (c) to develop a computerized design and cost model giving the cost responses to the input variables, (d) to test this model on many feasible input data combinations, and (e) to develop generalized relationships between physical conditions and the costs of injection. Physical relationships in common usage in the petroleum industry were modified where necessary and used to describe the behavior of the injection system. Cost data were collected from a variety of sources, especially the petroleum and chemical engineering fields. The results of this study indicate that deep well injection of aqueous wastes is both technically and economically feasible under certain conditions. The cost of this operation may run upward from a minimum of 0.25 - 0.40 dollars per thousand gallons, including minimal pre-injection treatment and amortization of the initial capital investment. The capital cost of such systems appears to vary from \$0.30 to over \$2.00 per thousand gallons per day for a 10 to 0.10 MGD system, respectively. (Aguirre-Texas)

W70-07033

SULFIDE PRODUCTION IN WASTE STABILIZATION PONDS,

Texas Univ., Austin. Center for Research in Water Resources.

Ernesto Espino de la O, and Earnest F. Glynna. Environmental Health Engineering Research Laboratory, Report EHE-04-6802, CRWR No. 26, May 1967. 156 p, 50 fig, 33 tab, 75 ref. FWQA Contract WP-00688-03.

Descriptors: *Hydrogen sulfide, *Organic loading, *Sulfates, *Sulfides, Algae, Gases, Odor, Oxidation-reduction potential, Sulfur bacteria, *Waste water treatment, *Oxidation lagoons, *Model studies.

Identifiers: Detention time, Laboratory models, BOD removal rates, Design applications, Facultative ponds, Infrared spectroscopy, Sulfur compounds, Waste stabilization ponds.

Laboratory models, under controlled environmental conditions, were used to investigate the production and release of hydrogen sulfide from waste stabilization ponds. A 6 foot deep model facultative pond was studied under seven different operating conditions. The experiments evaluated the relationship between sulfide concentration in the pond

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Group 5D—Waste Treatment Processes

and four operating characteristics: detention, concentration of sulfate ion in the influent, BOD surface load and sulfate ion concentration in terms of surface load. At constant detention time and BOD surface load, a linear relationship was found to apply between sulfide concentration in the pond and sulfate concentration in the influent. Increases in sulfide concentrations in the pond from zero to 1 and 2 mg/l were accompanied with drops in oxidation-reduction potentials of 80 and 120mv, respectively. Further increases in sulfide concentration affected the ORP in a lesser way. Sulfide concentrations in the pond of about 7 mg/l were accompanied by an almost complete disappearance of algae, but the BOD removal rates were not appreciably affected. Infrared spectroscopy was used to identify methane, hydrogen sulfide and carbon dioxide in the gaseous emissions from the pond. (Aguirre-Texas)
W70-07034

EXPANSION OF SOUTH CHARLESTON WASTE TREATMENT PLANT,
Union Carbide Corp., South Charleston, W. Va.
R. A. Payne, G. W. Kumke, and A. H. Cheely.
Journal of the Water Pollution Control Federation, Vol 41, No 4, p 535-546, April 1969. 6 fig, 4 tab, 3 ref.

Descriptors: Expansion, *Biomass, *Biochemical Oxygen Demand, Activated sludge, Aeration, Pilot plant, *Waste water treatment, Municipal waste, Industrial waste, West Virginia.
Identifiers: Plant design, *Secondary treatment, *Aerobic reactors, *Clarifiers, Aeration basin, Aerators, pH control, Charleston (W Va).

The 1968 expansion of the South Charleston, West Virginia, waste water treatment plant provide secondary treatment for an average municipal-industrial waste flow of 17 mgd increasing the plant biochemical oxygen demand removal from 40,800 lb/day to 103,000 lb/day. Two pilot-plant systems, 55 gal baffled drum aerobic reactors with biomass recycled continuously from an insulated clarifier, were operated in parallel to establish operating parameters. The nitrogen demand of the biomass was 5% of BOD₅ removed. Data indicated that 1.2 lbs of oxygen were consumed per lb of BOD₅ removed; 90% reduction of BOD₅ was achieved in 10 hours; a straight line relationship was established between solids accumulation per pound of BOD₅ removal/day and detention time. The resulting expansion equipment include a unique ash cement lined 6.5 mil gal aeration basin, 18 surface aerators, 2 final clarifiers, recycle pumps, sludge pumps, modifiers to pH controls, and instrumentation. (Waid-Texas)
W70-07035

RAPID INSTRUMENTAL MEASUREMENT OF ORGANIC LOAD IN WASTE WATERS,
Rocketyne, Canoga Park, Calif.
I. Lysyj, K. H. Nelson, and H. Snell.
Journal of the Water Pollution Control Federation, Vol 41, No 5, p 831-835, May 1969. 1 fig, 2 tab, 3 ref.

Descriptors: *Biochemical oxygen demand (BOD), *Laboratory equipment, *Effluents, Organic matter, Organic loading, Treatment facilities, Instrumentation, Measurement, *Analytical techniques.
Identifiers: *Pyrolysis, Pyrographic technique, Non-biodegradable matter.

Equipment, procedures and calculations of a pyrographic technique for the determination of total organic content of waste waters are described. Results are calculated as oxygen demand similar to those from the biochemical oxygen demand (BOD) test. Application of this technique to raw waste water and primary treated effluents produced results differing by only 5% from parallel standard 5-day BOD determinations. Relative amounts of biodegradable and nonbiodegradable components of secondary treated effluents were predicted when

the pyrographic technique results were compared with 5-day BOD test results. (Sorber-Texas)
W70-07037

NEW YORK'S HUDSON RIVER BEND COMPREHENSIVE SEWERAGE STUDY,
Rist-Frost Associates, Glens Falls, N.Y.
M. Vonic, and J. C. Bumstead.

Journal of the Water Pollution Control Federation, Vol 41, No 4, p 553-566, April 1969. 13 fig, 2 tab, 4 ref.

Descriptors: *Sewerage, *Waste water (Pollution), *Pollution abatement, *Economics, *Industrial waste, *Municipal waste, *Costs, River flow, Stream gauges, Biochemical oxygen demand, Dissolved oxygen, Liquid waste, Treatment facilities, New York.

Identifiers: *Waste characteristics, *Hudson River, Population growth, Hudson River (NY).

This paper describes a workable engineering framework of a \$26,000,000 plan for the implementation of two treatment plants, one to treat 32.5 mgd and the other, 6.4 mgd of combined municipal and industrial wastes, which would reduce and control pollution of the Upper Hudson River. The plants would serve 8 municipalities and four major industries (paper and dye) around the city of Glens Falls. The size of the plants is the result of a study which estimated the population to be 100,000 by year 2000. The study also analyzed the river flow and indicated the major portion of the waste loadings to be of an industrial nature and based on biochemical oxygen demand the equivalent population presently affecting the study area is 550,000 - 9 times the actual population. The report recommends a Tri-county Sewer District Agency be created to administer the proposed sewer district allocating the cost of the treatment plant on the basis of flow, biochemical oxygen demand, and suspended solids. (Waid-Texas)
W70-07038

AERATION IN WASTE WATER TREATMENT - MOP 5.

Water Pollution Control Federation, Washington, D.C. Technical Practice Committee.

Journal of the Water Pollution Control Federation, Vol 42, No 1, p 51-76, January 1970. 2 fig, 6 tab, 116 ref.

Descriptors: *Aeration, *Waste water treatment, Analytical techniques, *Operation and maintenance, *Maintenance, Operations.

Identifiers: Aerators, *Air diffusers, *Mechanical aerators, *Diffuser cleaning, Air blowers, Air filtration, Air piping.

This report is the third and concluding installment of the serialization of the manual 'Aeration in Waste Water Treatment.' The manual is intended to provide designers, operators, and maintenance personnel of waste water treatment facilities with the fundamental theory and operational aspects of aeration. This third installment deals with the operation and maintenance of the diffuser system. The report indicated that proper records should be kept showing the pertinent information to insure proper service. Causes of diffuser clogging and techniques for cleaning diffusers is presented. The report also presents the operation and maintenance procedures for various types of air filters, mechanical aerators and connected aeration equipment, such as air piping, distribution control, air blowers and gear motors. (Waid-Texas)
W70-07039

COMBINED TREATMENT OF WOOL SCOURING WASTES AND MUNICIPAL WASTES,
A. Petru.

Journal of the Institute of Sewage Purification, No 5, p 497-499, 1964.

Descriptors: *Municipal wastes, Calcium hydroxide, Calcium chloride, Centrifugation, Biochemical Oxygen Demand, Chemical Oxygen Demand, Textiles, Fibers (Plant).

Identifiers: *Wool scouring wastes, Wool, Wool grease, Wool scouring.

Pilot-plant experiments showed that, after pretreatment with calcium hydroxide and calcium chloride and a centrifuging treatment to remove as much wool grease as possible, wool scouring wastes can be treated together with municipal wastes in a ratio of 1:10. Reduction in BOD was of the order of 70 percent and that in COD of 40-60 percent. (Mattox and Livengood-North Carolina State Univ)
W70-07040

DISPOSAL OF EFFLUENT,
Shirley Inst., London (England).

D. W. Hill.
Textile Weekly, Vol 65, No 2, p 841-842, 1965.

Descriptors: *Activated sludge, Biochemical oxygen demand, *Trickling filters, Biological treatment.

Identifiers: *Dyehouse wastes, *Finishing waste.

A washing parameter concept allows the calculation of possible efficiency in the washing process, and its use may enable a plant to save several thousand gallons of water per day at one process. Organic matter in a plant's effluent solution can be oxidized to simple substances by bacteria in the presence of dissolved oxygen, reducing the effluent's biochemical oxygen demand. Process efficiency depends on the concentration of organic matter and the presence of inorganic materials that may assist or interfere with the microorganisms. Two main methods of biological purification are the trickling filter and activated sludge. (Sheffield and Work-North Carolina State Univ)
W70-07041

THE ADVANTAGES OF INDUSTRIAL-MUNICIPAL WASTE WATER TREATMENT,
General Electric Co., Schenectady, N.Y.

K. S. Watson.
Journal of the Water Pollution Control Federation, Vol 42, No 2, Part 2, p 209-217, February 1970. 1 fig, 4 tab, 15 ref.

Descriptors: *Municipal wastes, *Industrial wastes, Economics, Financing, *Waste water treatment, Regions.

Identifiers: *Sanitary district, *Joint treatment, Equitable finance formula, Combined treatment.

Combining the wastes from the industries and municipalities in a regional system provides the most economic treatment for an area, and since the operation is larger, full-time professional operation and management is improved. In planning the regional approach a study of the area under consideration is required, which is accomplished when either municipalities or industries takes the lead and start organizing study committees. Once the sanitary district is established, its powers are exercised by or through a board of governors, directors, or trustees. Five cases illustrating aspects of this approach are given. Limits are set for acceptance of industrial waste to protect the treatment plant. Seven approaches for financing the handling of waste water and their merits are presented. In spite of the soundness of the joint approach it is not practiced widely due to the inability of the political sub-divisions of a region to get together. (Waid-Texas)
W70-07042

AGGREGATE SIZE VARIATIONS DURING THICKENING OF ACTIVATED SLUDGE,
Illinois Univ., Urbana. Sanitary Engineering Lab.
Ali R. Javaheri, and Richard I. Dick.

Journal of the Water Pollution Control Federation, Vol 41, No 5, Part 2, p R197-R214, May, 1969. 31 fig, 19 ref.

Water Treatment and Quality Alteration—Group 5F

Descriptors: *Activated sludge, *Aggregates, *Settling velocity, *Waste water treatment, Porosity, Separation techniques, Solid wastes.
Identifiers: *Settling characteristics, *Aggregate size, Thickening, Solids separation.

This study investigates the fundamental physical behavior of activated sludge during thickening to determine the effectiveness of the solids separation and consolidating phases. Settling tests were conducted on samples from three different activated sludge treatment plants using four 3.5 inch diameter columns, reservoirs, pumps, and a piping system. Sludge was pumped to a height of 3.5 feet in the columns insuring a homogeneous distribution of solids. Subsidence of the sludge interface was then observed and analyzed for interface subsidence velocity and for the water content and size of aggregates. The data analysis showed that aggregate became smaller, more numerous, and more dense as thickening takes place and water elimination depended on two mechanisms: 'squeezing' and 'splitting.' Activated sludges with good settling characteristics have low ASI, aggregate squeeze index, and high porosity, and thickening occurs primarily by elimination of interstitial water. In contrast, sludges with poor settling characteristics have high ASI and low porosities. (Waid-Texas)
W70-07043

MASS TRANSFER LIMITATIONS IN SUBSTRATE REMOVAL,
Michigan Technological Univ., Houghton. Dept. of Civil Engineering.

C. Robert Baillod, and William C. Boyle.
Journal of the Sanitary Engineering Division, ASCE, Vol 96, No SA2, p 525-545, April 1970. 11 fig, 1 tab, 31 ref. FWQA Research Grant WP-00905-03.

Descriptors: Bacteria, Diffusion, *Diffusivity, *Flocculation, Hydraulic models, *Activated sludge, *Mass transfer, Sanitary engineering, Waste water treatment.
Identifiers: *Oxygen uptake rates, *Glucose uptake rates, Zoogloea ramigera.

This paper establishes the existence of an intraparticle diffusional resistance in the uptake of organic substrate by particles of zoogloal floc, Zoogloea ramigera, strain I-16-M, by comparing the glucose and oxygen uptake rates for large floc particles with those exhibited by the same particles after blending. The results showed that, at high glucose concentrations (above 2 mg/l to 8 mg/l) the oxygen and glucose uptake rates of both the flocculated and blended particles exhibited zero order kinetics and thus independent of glucose concentrations. A zero order effectiveness factor model predicting the magnitude of mean effective diffusivity for glucose in the floc material to be 2.625×10 to the -8th power ($T C$)- 9.75×10 to the -8th power in square centimeters per second for the range 20C to 30C, is developed by considering the floc particles to be analogous to a porous catalyst particle. In a similar experiment, subjecting activated sludge floc particles to high turbulence caused a marked increase in the oxygen uptake rate, apparently due to the solubilization of some sludge components. (Waid-Texas)
W70-07044

BEEF FEEDLOT OPERATIONS IN ONTARIO,
Department of Energy, Mines and Resources, Burlington (Ontario). Canada Centre for Inland Waters.

A. R. Townsend, S. A. Black, and J. F. Janse.
Journal of the Water Pollution Control Federation, Vol 42, Part 1, p 195-208, February 1970. 3 fig, 10 tab, 10 ref.

Descriptors: *Livestock, *Farm management, *Farm lagoons, *Runoff, Seepage, Waste storage, Waste disposal, *Farm wastes.
Identifiers: *Cattle feedlots, *Animal housing, *Manure storage.

The beef feedlot industry in Ontario is described with respect to its environmental pollution problem. Approximately 100,000 cattle are on Ontario feedlots with an estimated 300 head or less per feedlot. Four different types of housing and the associated handling of animal wastes as well as types of pollution from the feedlots is discussed. Animal waste storage should be designed to provide six months capacity and lot runoff storage facilities should be sized to hold the winter snow melt and spring rains until proper waste disposal. The report concludes that feedlot waste disposal will continue to be storage and land disposal rather than treatment and effluent discharge. The three main causes of pollution have been feed storage seepage, feedlot runoff, and land disposal runoff. This report recommends aeration systems such as rotors, aspirators, surface mechanical, and diffused air tubing for odor control. (Waid-Texas)
W70-07045

HYDRAULIC DESIGN OF SELF-CLEANING SEWAGE TUNNELS,

Norges Tekniske Hoegskole, Trondheim.

Dagfinn K. Lysne.

Journal of the Sanitary Engineering Division, ASCE, V 95, No SA1, p 17-36, February, 1969. 15 fig, 8 ref.

Descriptors: *Design, *Tunnel design, Dimensions, Hydraulics, Shape, Slopes, *Sewage.

Identifiers: *Sewage tunnels.

The different factors affecting the hydraulic design of self-cleaning sewage tunnels with a free water surface are described. It is found that the two most important problems involved are related to shear stress distribution and critical shear stress to secure self-cleaning. Based on a shear stress distribution normally assumed for open channels, a trapezoidal bottom shape is suggested. A value for critical shear stress to prevent settlement of sand in a mixture of waste water is recommended, but design data are also included for alternative values of critical shear stress. Curves for determining shape, slope, and size of tunnels with known minimum and maximum rate of flow are given. (DiFilippo-Texas)
W70-07046

A COMPARISON OF STONE-PACKED AND PLASTIC-PACKED TRICKLING FILTERS,

Eastman Kodak Co., Rochester, N.Y.

Bruce A. Wing, and William M. Steinfeldt.

Journal of the Water Pollution Control Federation, Vol 42, No 2, Part 1, p 285-264, February 1970. 18 fig.

Descriptors: *Biological treatment, *Pilot plant, *Trickling filters, *Waste water treatment, *Biochemical oxygen demand, Neutralization, Nutrients, Industrial waste, Efficiency, Aeration.

Identifiers: *Recirculation, *Secondary treatment, *Stone filter, *Plastic-packed filter, Zinc pH control, Hydraulic loading, Forced-air ventilation.

A 21 ft diameter stone filter and a 3 ft diameter plastic-packed filter were compared using the primary treatment plant effluent that had been pumped through a neutralization tank. The pH was controlled using 40% H₂SO₄ and 20% NaOH. The results showed that pH control was mandatory if the pH varied outside the range of 5.0 to 9.0. Forced-air ventilation improved the performance of stone-packed filter by 14% and recirculation by 36%. Both filters achieved over 80% removal. Zinc concentrations as high as 8 mg/l and nutrient additions did not affect efficiency. Hydraulic loading was the only variable influencing the plastic-packed filter efficiency and the plastic media 21.5 ft in depth required less than one-fifth of the land area required by an 8 ft. deep stone-packed filter. (Waid-Texas)
W70-07048

5E. Ultimate Disposal of Wastes

SLUDGE HANDLING,

Potter (Alexander) Association, New York.

For primary bibliographic entry see Field 05D.
W70-06891

ALTERNATIVES FOR SLUDGE DISPOSAL, METROPOLITAN SEWERAGE SYSTEM,

San Diego Dept. of Utilities, Calif.

Harvy M. Cole, Jr.

November 1968. 85 p, 9 fig, 11 ref.

Descriptors: *Sewage disposal, *Sludge disposal, *Oceanography, *Sludge treatment, *Water quality control, *Costs, *Landfills, *Hydraulic conduits, Incineration, Deserts.

Identifiers: *San Diego, *Sewage sludge disposal.

The problems and alternatives in the handling and disposal of sewage sludge from the San Diego Metropolitan sewerage system are described. San Diego has a continuing problem of finding sites for solid wastes disposal. For the next 10 years though, the canyons surrounding Miramar Air Station will be used for sanitary fill operations. On the basis of cost factors only, three basic alternatives that are suited to the San Diego area are compared. The classifications are: (1) Ocean Disposal, (2) Combustion and Ash Disposal, and (3) Land Disposal of Liquid Sludge. It was concluded that hauling wastes to the desert and various methods of incineration are expensive and should not be considered unless after alternatives of land and ocean disposal prove to be unacceptable. Combustion of sludge has disadvantages. The present method of shipping waste to Fiesta Island is highly desirable and the cost is low, but may be terminated soon. Disposal to the ocean through an outfall is advantageous but is not permitted by present policies of the Water Quality Control Board. Further research is suggested. (Poertner-Chicago)
W70-06916

LIQUID WASTE DISPOSAL IN THE LAVA TERRANE OF CENTRAL OREGON,

Federal Water Pollution Control Administration, Corvallis, Oreg. Pacific Northwest Water Lab.

For primary bibliographic entry see Field 05B.
W70-06962

LIQUID WASTE DISPOSAL IN THE LAVA TERRANE OF CENTRAL OREGON (Appendix),

Federal Water Pollution Control Administration, Corvallis, Oreg. Pacific Northwest Water Lab.

For primary bibliographic entry see Field 05B.
W70-06963

DISPOSAL OF EFFLUENT,

Shirley Inst., London (England).

For primary bibliographic entry see Field 05D.
W70-07041

5F. Water Treatment and Quality Alteration

A STEADY STATE OPTIMAL DESIGN OF ARTIFICIAL INDUCED AERATION IN POLLUTED STREAMS BY THE USE OF PONTRYAGIN'S MINIMUM PRINCIPLE,

Rutgers - The State Univ., New Brunswick, N.J.; and Electronic Associates, Inc., Princeton, N.J.

Burton Davidson, and Robert W. Bradshaw.

Water Resources Research, Vol 6, No 2, p 383-397, April 1970. 15 p, 13 fig, 1 tab, 17 ref. OWRR Projects, A-017-NJ and B-011-NJ.

Descriptors: *Aeration, *Water pollution treatment, *Optimization, *Computer programs, Digital

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Group 5F—Water Treatment and Quality Alteration

computers, Analog computers, Systems analysis, Synthetic hydrology, Costs, Cost analysis, Cost-benefit analysis, Dissolved oxygen, Mathematical models.

Identifiers: Control theory.

Optimal control theory based on Pontryagin's minimum principle was applied to the steady state distribution of artificial aeration in polluted rivers. The optimization was developed for a general integral type cost functional with weighted energy constraints. The system equations used were of the classical Streeter-Phelps type with an induced aeration term added as the control function. Several optimal and suboptimal aeration designs at different temperature levels were obtained using a digital computer and an automatic plotting routine. An analog computer was used in the critical stages of the numerical solutions. Results from the analog computer pointed the way to the ultimate use of Laplace transform techniques in conjunction with a digital computer for maximum accuracy. (Knapp-USGS)

W70-06743

INNOVATION IN MEMBRANE FILTER TECHNIQUE AS APPLIED TO WATER BACTERIOLOGY,

Denver Board of Water Commissioners, Colo.

For primary bibliographic entry see Field 05A.

W70-06914

5G. Water Quality Control

AIR-SEALING COAL MINES TO REDUCE WATER POLLUTION,

Bureau of Mines, Pittsburgh, Pa. Coal Mining Research Center.

N. N. Moebis, and Stephen Krickovic.

Bureau of Mines Report of Investigations 7354, March 1970. 33 p, 21 fig, 5 tab.

Descriptors: *Acid mine water, *Water pollution control, Oxidation, Oxygen, Waterproofing, Mine drainage, Water pollution treatment, Mine acids, Acid streams.

Identifiers: Mine sealing.

The Bureau of Mines air-sealed a 77-acre, above-drainage coal mine to evaluate sealing as a means of reducing the acid and metallic salt contents in drainage from abandoned mines. An approximate reduction in acidity of 150 ppm (equivalent to 193 pounds per day) and in iron of 98 ppm were directly attributed to sealing. The topographical, hydrological, and other factors involved in air-sealing are discussed, and the construction used to seal the mine is described. (Knapp-USGS)

W70-06734

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOLUME II, APPENDIX.

Federal Water Pollution Control Administration, Washington, D.C.

For primary bibliographic entry see Field 06B.

W70-06839

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOLUME III, (SEWERAGE CHARGES).

Federal Water Pollution Control Administration, Washington, D.C.

For primary bibliographic entry see Field 06B.

W70-06840

CONNECTICUT'S ADMINISTRATIVE CONTROL OF WATER POLLUTION -- THE FLUID ADMINISTRATIVE PROCESS,

Connecticut Univ., Inst. of Water Resources.

Theodore H. Focht.

Available from the Clearinghouse as PB-191 872, \$3.00 in paper copy, \$0.65 in microfiche. Connecticut University Water Resources Institute Report

No 8, April 1969. 44 p, 76 ref, 3 append. OWRR Project A-012-CONN (3).

Descriptors: *Water pollution control, *Connecticut, Legal aspects, Regulation, Water law, Legislation, Public rights, Water policy, Water distribution (Applied), Water utilization, Water quality. Identifiers: Connecticut water pollution control.

The present status of administrative regulation of water rights in Connecticut is outlined, especially as it operates in the area of pollution control. Two administrative case studies are extensively examined to reveal insights into the way the administrative process has worked. New water pollution legislation will be examined to consider to what extent it may help the administrative regulation of these problems, and some suggestions of what might be done to achieve the goal and objective of a more responsive and responsible administrative system are offered. (Knapp-USGS)

W70-06844

PROFESSIONALISM AND WATER POLLUTION CONTROL IN GREATER CHICAGO,

Metropolitan Sanitary District of Greater Chicago, Ill.

For primary bibliographic entry see Field 05D.

W70-06871

POTENTIAL IMPACT OF TUNNELS ON WATER POLLUTION AND FLOOD CONTROL IN THE CHICAGO AREA,

Metropolitan Sanitary District of Greater Chicago, Ill.

Forrest C. Neil.

Paper presented at the Annual and Environmental Meeting of the American Society of Civil Engineers, Chicago, October 13-17, 1969. 21 p, 6 fig.

Descriptors: *Underground storage, *Tunnels, *Control structures, *Sewers, *Flood control, *Water pollution control, Water conveyance, Waste water, Shafts, River regulation, Drainage systems, Drainage engineering, Design, Underflow. Identifiers: *Chicago.

A novel approach to the solution of water pollution and flood control problems in Metropolitan Chicago is described. It is a part of a \$2 billion, 10 year approach to meet water quality standards and permit higher uses of the waterways. The present combined-sewer systems cannot handle the tremendous quantities of waste water inputs during periods of precipitation when stormwater runoff is appreciable. Wastes discharged to the canal system, as a result of combined-sewer overflows, are contributing to the pollution of Lake Michigan and the Chicago, Des Plaines, Illinois and Mississippi Rivers. Diversion water from Lake Michigan is presently employed to control pollution of the sanitary canal system. Sewer separation alone would not improve water quality in the waterways sufficiently to meet established standards. A separate sanitary sewer system would cost over 4 billion dollars. Loss of business caused by construction interferences would add considerably to this figure. Therefore a system of deep tunnels for temporary subsurface storage of combined-sewer overflows is desirable. The stored waters will be pumped to the surface, upon cessation of runoff, for normal flow to the treatment plants. This unusual method could be achieved at less than 25 percent of the cost of sewer separation, using rock mole machines. (Poertner-Chicago)

W70-06926

THE ECONOMICS OF WATER QUALITY,

Rutgers - The State Univ., New Brunswick, N.J. Water Resources Research Inst.

Willian Whipple.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec 1-3, 1965, Urbana, Illinois, 1966, p 225-242, 4 fig, 1 tab, 7 ref.

Descriptors: *Economics, *Water pollution control, *Methodology, Water utilization, *Consumptive use, Withdrawal, Economic justification, Evaluation, Benefits, Supply, Demand, Waste water disposal, Pricing.

Section I discusses the confusion generated by the terms 'consumptive use' and 'withdrawal.' It recommends that water be regarded as used when it receives sufficient effluent wastes to reduce it to minimum acceptable standards. The research necessary to apply this concept statistically is discussed. Section II discusses problems in finding a quantitative measure to justify pollution control economically. The possibility is demonstrated of evaluating economic benefits fairly. Section III postulates the measurement of benefits and formulates the problem of applying supply-demand principles to the disposal flows. Sections IV and V provide an economic analysis of disposal flows. First, the case of simple pollution is considered, so that the economic relationships of a single type of waste can be considered separately. Then, a method is presented to analyze the complex case, where different types of waste have a combined effect on various types of values. Section VI discusses the economic basis for effluent charges and subsidies. A procedure is presented which assures that effluent treatment and stream quality are properly balanced, and that each plant, wherever located, pays the correct cost resulting incrementally from its presence on a stream. (Gossen-Chicago)

W70-06937

THE USE OF URBAN UNDERGROUND SPACE IN STORM WATER MANAGEMENT IN CHICAGO,

Harza Engineering Co., Chicago, Ill.

Richard D. Harza.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 52-55.

Descriptors: *Systems analysis, *Discharge (Water), *Storm runoff, *Water quality control, *Diversion, *Tunneling, Drainage, Land use, Sewage treatment, Electric power production, Population.

Identifiers: *Chicago Deep Tunnel Plan, *Chicago river system, Combined sewers.

The Chicago Deep Tunnel Plan is described from a systems analysis standpoint and a status report of the pilot project Lawrence Avenue 'Underflow Tunnel' is given. Nine existing systems in the Chicago area are discussed and related to the plan. Aspects of the hydrological system and geological and geographical system are mentioned as bringing about the need for lake diversion and creating drainage problems. At the same time, however, the area is highly suitable for tunneling. The human population system introduces needs for fresh water which vary considerably during the day and with increasing living standards. The system of existing land and structural building improvements introduces tremendous costs for land acquisition and disturbance of patterns of commerce and culture. The Chicago river system and the electronic power generating system are mentioned. The sewage treatment facility system and the combined sewer system at present bring problems of unused capacity in the daily 24-hour period and problems of overflow during wet weather. Finally, the system of legal requirements limits diversion and sets water quality standards demanding change in present conditions. The Deep Tunnel Concept is discussed with regard to these systems and two other possibilities of handling storm runoff are outlined: immediate full capacity conveyance and weather control. It is concluded that the Deep Tunnel involving a detention-and-conveyance system with a steep hydraulic gradient and a pump storage plant would be the most effective. (Preckwinkle-Chicago)

W70-06942

Water Quality Control—Group 5G

CHARACTERIZATION AND CONTROL OF OVERFLOWS FROM COMBINED SEWERS,
Engineering-Science, Inc., Forest Hills, N.Y.; and
Engineering-Science, Inc., Arcadia, Calif.

David W. Eckhoff, Alan O. Friedland, and Harvey F. Ludwig.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 68-84, 5 fig, 5 tab, 5 ref.

Descriptors: *Overflow, *Water quality, *Water treatment, *Discharge (Water), *Chlorination, Storm runoff, Effluents, Surface runoff.

Identifiers: *Combined sewers, *Dry weather monitoring, *Wet weather monitoring, *Coliform determinations, *Dissolved air flotation, *Mass discharges.

With realization of major water pollution problems resulting from combined sewer overflows from urban areas, measures must be developed for controlling or satisfactorily treatment such discharges, consistent with the available technological capability for the protection of beneficial water uses. The objectives of this study in San Francisco were to go beyond previous fragmentary analyses and this involved four unknowns: (1) characterizing combined sewer overflows for representative urban areas in terms of both quantity and quality; (2) determining the significance of combined sewer overflows with respect to other urban waste discharges; (3) evaluating the effects of combined sewer overflows on receiving waters; and (4) assessing feasible control and/or treatment methods for achieving water quality objectives. Description of the study area and of the two pilot sectors is given. Four methods of study are described: dry weather monitoring, wet weather monitoring, receiving water coliform studies, and dissolved air flotation experiments. Results and discussion of these methods plus calculations of mass discharges follows. It is concluded that the treatment of combined sewer overflows is a more feasible alternative to the problem of receiving water pollution than is separation of combined systems. Dissolved air flotation with chlorine disinfection is also concluded to be a promising treatment method for combined sewer overflows. (Preckwinkle-Chicago)

W70-06943

COMPUTER CONTROL OF COMBINED SEWERS,

Minneapolis-St. Paul Sanitary District, Minneapolis, Minn.

James J. Anderson.

Saint Paul, Minn.; Watermation, Inc., October 1969. 19 p, 26 fig, 8 tab, 22 ref. Facilities Demonstration Grant No. 1, Fed. Water Pollution Control Administration, U.S. Dept. of the Interior.

Descriptors: *Automatic control, *Gate control, *Computers, *Regulated flow, *Control systems, *Pollution abatement, *Surface runoff, *Remote sensing, *Telemetry, *Dynamic programming, *Flow control, Sewers.

Identifiers: *Minneapolis-St. Paul Sanitary District, *Combined sewers, *Overflow regulators.

This paper describes a unique application of digital computers for maximizing the capture of urban runoff in the combined-sewer system of the Minneapolis-St. Paul Sanitary District. The real-time dynamic computer control of system overflow-regulators proved effective in helping to increase flows in interceptor sewers, thus reducing the frequency of overflows of raw sewage to the Mississippi River. Major overflow regulators were modified by replacing floats on the gates with hydraulic cylinders. Inflatable dams were installed in trunk-sewer outlets. Level-sensing bubbler tubes with transducers and gate position slidewires were installed to provide sewer level and regulator-status information. Control and telemetry equipment were installed in underground vaults. The data acquisition and control system provides both manual-remote as well as automatic control of the system by central computer using leased telephone

wires. The author describes the river monitoring and wastewater sampling methods employed, the rain gage installations, mathematical modeling, and operating methods. He concludes that the feasibility of controlling and operating a large combined-sewer system, using centralized computer control, has been demonstrated and that this data acquisition system will facilitate future testing of improvements in water resource management. (Poertner Chicago)

W70-06954

IMPROVING THE SOUTHERN ENVIRONMENT,

Tennessee Valley Authority, Knoxville.

Frank E. Smith.

The L.Q.C. Lamar Society and Southwestern at Memphis, Symposium on 'The Emerging South', Memphis, Tennessee, April 18, 1970. Typescript, 18 p.

Descriptors: *Water pollution control, *Air pollution, Abatement, *Quality control.

Identifiers: Tennessee Valley Authority, *Economic development.

The South has not been concerned about the quality of the environment for the South has been preoccupied with attaining an adequate share of the prevailing affluence. Industrial development has lead to pollution, but the desire for greater economic development has allowed the continuing pollution of the South's waters. The South's economic base must expand by continued development of its natural resources. Adequate environmental controls for the Tennessee Valley Authority power generating facilities are discussed. Steps to protect the Southern environment and improve its quality are presented. (Grossman-Rutgers)

W70-06958

ELKINS MINE DRAINAGE POLLUTION CONTROL DEMONSTRATION PROJECT,

Robert A. Taft Water Research Center, Cincinnati, Ohio.

Ronald D. Hill.

Available from the Clearinghouse as PB-191 876, \$3.00 in paper copy, \$0.65 in microfiche. Paper Presented Before the Third Symposium on Coal Mine Drainage Research, Mellon Institute, Pittsburgh, Pennsylvania, p284-303, May 20, 1970. 14 tab, 5 fig, 4 ref. FWQA Project 14010--04/70.

Descriptors: *Mine drainage, West Virginia, *Acid mine water, Waste water (Pollution), Mine wastes, *Strip mine wastes, Water pollution control, *Revegetation, *Reclamation, Land reclamation.

Identifiers: Elkins (West Virginia).

In 1964, a mine drainage pollution control demonstration project was undertaken near Elkins, West Virginia. The area contained a large drift mine (3,000 acres) which had been extensively surface mined along the outcrop. The objective of the project was to determine the effect on the water quality of 'air' sealing and diverting water away from the underground mine and reclaiming the surface mines. Some 450 subsidence holes were filled, over 12.5 miles of surface mines were reclaimed and 101 seals constructed. Approximately 640 acres of land were disturbed during reclamation which were revegetated in the spring of 1968. This paper reports the effectiveness of the reclamation work for the first two years following construction. The reclamation and revegetation of the surface mines and refuse piles have shown some benefits, however, an equilibrium condition has not been established and the long term effects have yet to be determined. While some areas have shown trends of continued improvement, others showed an improvement the first year, followed by some deterioration the second year. Air sealing, under the conditions at Elkins was unsuccessful, except for one site, the oxygen concentration behind the seal has not decreased and the pollution loads have not decreased. For the combined watershed of Roaring Creek and Grassy Run there has been over a 1,500

ton decrease in the acidity load for the base year 1966. However, none of the streams in either watershed has returned to its unpolluted state. W70-06965

REAL TIME ROUTING OF FLOOD HYDROGRAPHS IN STORM SEWERS,

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.

For primary bibliographic entry see Field 07B.
W70-06977**WATER RESOURCES OF IOWA.**

Iowa State Geological Survey, Iowa City.

For primary bibliographic entry see Field 06B.
W70-06981**A PILOT STUDY OF STORAGE REQUIREMENTS FOR LOW FLOW AUGMENTATION,**

Corps of Engineers, Sacramento, Calif. Hydrologic Engineering Center.

Augustine J. Fredrich.

Paper presented at 49th Annual Meeting of the American Geophysical Union, Washington, D C, April 8, 1968. 16 p, 6 exhibit, 3 ref.

Descriptors: *Systems analysis, *Computer programs, *Low-flow augmentation, *Reservoir design, Optimization, Synthetic hydrology, Reservoir operation, Flow control, Regulation, Waste dilution.

Identifiers: Storage requirements (Water).

By supplementing traditional sequential routing techniques with a relatively simple optimization process and with appropriate generalized physical data it is possible to develop a screening procedure which provides simple application and rapid evaluation of flow augmentation needs and which utilizes most of the available physical data in order to minimize the possibility of an erroneous ranking of alternatives. A pilot study consisted of an analysis of storage requirements for low-flow augmentation to meet pre-established quality demands at 46 locations in the Grand River Basin, Missouri and Iowa. The studies required approximately 8 minutes of computer time on the Control Data Corporation (CDC) 6600 computer. Data preparation for the computer required less than 10 man-hours for the 92 studies. The procedure is flexible enough to consider all available physical and hydrologic data relative to the design and operation of a reservoir project. However, use of the procedure is not limited to areas where a large amount of data is available because analyses may be performed utilizing generated or generalized streamflow data and the simplest reservoir operating rules. (Knapp-USGS)

W70-07029

RECOVERY OF HEAT FROM EFFLUENT (IN FRENCH),

A. Hilliard.

Rayonne et Fibres Synthétiques, Vol 20, No 12, p 1127-1138, 1964.

Descriptors: *Heat exchangers, *Effluents, Water pollution control.

Identifiers: *Waste heat recovery, *Polybloc heat exchanger, *Effluent liquors, Viscose rayon spinning plant, Bleaching bath, Viscose rayon.

The polybloc heat exchanger units are shown to be suitable for effluent liquors. The units are built up from perforated cylindrical metal discs, with polytetrafluoroethylene or graphite seals. Heat recovery units which embody this Polybloc exchanger are described with diagrams: one installation, in which heat from hot washing liquor effluent is used to preheat the bleaching bath in a viscose spinning plant, is described in particular detail. (Livengood and Robinson-North Carolina State Univ)

W70-07036

Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

Group 5G—Water Quality Control

COLD FACTS ON HOT WATER: LEGAL ASPECTS OF THEMAL POLLUTION,
Larry J. Jost.
Wisconsin Law Review, Vol 1969, No 1, p 253-269, 1969. 17 p, 77 ref.

Descriptors: *Pollution abatement, *Water pollution control, *Cooling water, *Thermal pollution, Heated water, Hydroelectric plants, Nuclear powerplants, Temperature, Steam turbines, Thermal power, Electric power production, Lakes, Rivers, Thermal stratification, Stagnant water, Taste, Water quality, Domestic water, Odor, Public health, Legal aspects, Legislation, Recreation, Fishkill, Oxygen sag, Decomposing organic matter, Cities, Reasonable use, Prior appropriation, Industrial plants, Industrial water.

Thermal pollution and the controls which it requires pose conflicting policy factors. The need for environmental protection must be balanced against the individual's rights. To determine what controls are needed we must determine the source of thermal pollution. The sources are linked principally to the generation of electrical power. Water from rivers and lakes is used to cool the nuclear and conventional generating machinery which in turn raises the temperature of such water. Methods for recooling this water are described. The effect of thermal pollution on water users is discussed. Three areas of water use are emphasized: domestic, industrial, and recreational. Two basic approaches to a legal solution of the problems of thermal pollution are through the rights of private individuals in litigation and through direct governmental action, both state and federal. No federal law exists on thermal pollution, but the existing pollution legislation and administrative agencies are discussed as they affect this problem. Sample state legislation is presented. In conclusion, a strong policy argument is made for the control of thermal pollution. (Barrett-Florida)
W70-07059

RELATIONSHIPS BETWEEN WATER QUALITY AND WATER RIGHTS,

R. B. Robie.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 72-82, 1970. 11 p, 28 ref.

Descriptors: *California, *Water rights, *Water utilization, *Impaired water quality, Riparian rights, Prior appropriation, Groundwater, Water quality, Competing uses, Diversion, Recirculated water, Water reuse, Legal aspects, Judicial decisions, Legislation, Administration, Non-consumptive use, Algae, Evaporation, Reasonable use, Brackish water, Domestic water, Geochemistry, Water chemistry, Salt balance.

A study of the interrelationships of water quality to water rights involves many legal aspects—riparian, appropriative and prescriptive rights, rights to the use of groundwater and reuse of water. Every exercise of a water right has some effect on water quality. The return flow of diverted waters may contain a higher concentration of minerals and salt than previously. The reduced flow caused by diversion may have several results including: (1) a reduction in the assimilative capacity of a stream; (2) larger evaporation losses; (3) increased stratifications; (4) accelerated algae growths; and (5) saline intrusion. Courts have long recognized water quality as a water right. Downstream riparian owners, for example, have been able to enjoin the irrigation use of an upstream riparian owner. Junior appropriators have been held liable for pollution that interferes with the rights of a senior appropriator. It is possible that the right to degrade water could be apportioned among users. A uniform approach is necessary however. Various statutory laws, case decisions, and administrative rules and regulations affecting the subject are discussed, especially as relates to California. (See also W70-07095). (Markee-Florida)
W70-07100

REGIONAL WATER QUALITY MANAGEMENT AND CONTROL,
For primary bibliographic entry see Field 06E.
W70-07101

A REVIEW OF THE TEXAS WATER PLAN: ISSUES AND ATTITUDES,
For primary bibliographic entry see Field 06E.
W70-07104

SEADEADE INDUSTRIES, INC V FLORIDA POWER AND LIGHT CO (CONDEMNATION OF LAND TO BUILD CANAL FOR COOLING OF WATER FROM NUCLEAR POWER PLANT).
232 So 2d 46-53 (3rd DCA Fla 1970).

Descriptors: *Florida, *Nuclear powerplants, *Canals, *Condemnation, Eminent domain, Public utilities, Legal aspects, Legislation, Public rights, Economics, Land tenure, Land use, Cooling, Engineering structures, Ecology, Thermal pollution, Environmental effects, Judicial decisions, Water pollution, Condemnation value, Economic impact, Bodies of water, Canal construction, Heated water.

Florida Power and Light Company sought to condemn plaintiff's land to build a canal for cooling heated water from defendant's nuclear powerplant. Plaintiff claimed that no necessity for the taking had been shown, and that the powers of condemnation had been abused. The court found that the defendant had reasonably concluded, taking into account economic and other factors, that such a canal was necessary to cool the water from the plant. It was held that defendant could not take a portion of the property for storage of the material excavated from the canal. The fact that the defendant Power Company had not obtained prior approval to discharge heated water into the sound was held no obstacle to its condemnation of the land in question. The court specifically refrained from ruling on legal aspects of discharging heated water into a nearby sound. (Caldwell-Florida)
W70-07106

SATREN V HADER COOPERATIVE CHEESE FACTORY (PREScriptive RIGHT TO POLLUTE).
279 NW 361-364 (Minn 1938).

Descriptors: *Minnesota, *Prescriptive rights, *Water pollution, *Pollution abatement, Boundaries (Property), Industries, Judicial decisions, Land tenure, Legal aspects, Proprietary power, Relative rights, Riparian lands, Riparian rights, Usurpationary right, Water rights, Disposal, Impaired water quality, Water pollution effects, Odor, Turbidity, Remedies, Reasonable use.

Defendant cheese factory discharged large amounts of whey into a stream which flowed through plaintiff's land. The whey caused a putrid odor to emanate from the stream and increased the turbidity of the water. When the cheese factory had initially begun operation, the amount of whey discharged into the stream had been so insignificant as to have no adverse effect on the water. As the operation grew, the pollution increased to the point where plaintiff brought suit for an injunction and damages. Defendant claimed that it had obtained a prescriptive right to pollute the stream and in any event that injunctive relief was not warranted since it would force defendant out of operation. The court held that a prescriptive right to maintain a nuisance cannot arise unless the nuisance has continued in substantially the same way and with equally injurious results for the entire statutory period. The evidence showed that the nuisance was not uniform in character or result. The court further held that a riparian owner may make, for business purposes, only a reasonable use of a stream flowing through his land. The extent to which defendant polluted the stream in question was held not reasonable. In such a case, injunctive relief was a proper remedy. (Clarke-Florida)
W70-07125

STATE EX REL MARTIN V CITY OF JUNEAU (MUNICIPAL POLLUTION).
300 NW 187-191 (Wis 1941).

Descriptors: *Wisconsin, *Local governments, *Pollution abatement, *Water pollution, Abatement, Human population, Judicial decisions, Legal aspects, Legislation, Public benefits, Public right, Public health, State governments, State jurisdiction, Impaired water quality, Water pollution effects, Administrative decisions, Water quality, Sewage, Water quality control, Administrative agencies, Cities, Municipal wastes, Effluents.

Defendant city was discharging into a drainage ditch sewage effluent which did not meet the minimum standards of public health and safety established by the State Board of Health and the State Committee on Water Pollution. A joint order was issued by the agencies commanding the city to install an adequate sewage treatment system within a specified period of time. The order was not complied with. The Attorney General sought a mandatory injunction to force compliance with the order and cessation of discharge of inadequately treated sewage. Defendant contended that the order was indefinite and in excess of the powers conferred by statute on the State Board and State Commission. The court held that the authority of the state legislature is supreme over that of a municipal corporation and that the promotion of public health is clearly a matter of state-wide concern. The Wisconsin statute giving the Committee and the State Board authority to promote public health clearly included regulation of water pollution. It also provided for administrative review procedures which defendant had not attempted to utilize. The joint order issued by the State Board and the Committee was not in excess of their statutory authority. Even if it was, however, defendant had not exhausted its administrative remedies. (Clarke-Florida)
W70-07129

AMERICAN BRASS CO V WISCONSIN STATE BOARD OF HEALTH (JOINT ORDER BY SEPARATE STATE AGENCIES: POLLUTION).
15 NW2d 27-32 (Wis 1942).

Descriptors: *Wisconsin, *Administrative agencies, *Pollution abatement, *Institutional constraints, Legislation, Sewage treatment, Treatment facilities, Sewage disposal, Public health, Water pollution, Surface waters, Water pollution control, Water quality control, Judicial decisions, Legal aspects, State governments, Coordination, Water policy, Industrial wastes, Remedies, Effluents, Administration, Political constraints.

Defendants, the State Board of Health and the State Committee on Water Pollution, issued a joint order to the plaintiff company relating to pollution of surface waters and requiring submission of plans for pollution abatement. Plaintiff appealed the order. The court found that the two agencies were completely separate, were set up by different statutes, and possessed separate areas of responsibility. The court held that there was no statutory foundation for such joint action and that the order was null and void. The fact that the powers of the agencies were complementary, the Board of Health dealing with sewage disposal from the standpoint of public health, and the Committee dealing with pollution of surface waters, was found not to justify the order in the absence of express statutory authority. (Caldwell-Florida)
W70-07130

JESSUP AND MOORE PAPER CO V ZEITLER (INDUSTRIAL POLLUTION OF STREAM—LOWER RIPARIAN RIGHTS).
24 A2d 788-792 (Md 1942).

Descriptors: *Maryland, *Riparian rights, *Beneficial use, *Pollution abatement, Streams, Rivers, Industrial wastes, Chemical wastes, Water pollution sources, Judicial decisions, Relative rights, Natural

flow, Mills, Water quality, Reasonable use, Water utilization, Pulp wastes, Stream pollution, Remedies.
Identifiers: Injunction (Prohibitory).

Three lower riparian owners sought an injunction against pollution of a stream by paper companies. Defendants demurred to the bill. The trial court overruled the demurser. In affirming, the appellate court stated that every riparian owner is bound to use a stream so as not to interfere with beneficial enjoyment by other riparian owners. A riparian owner has a right to the enjoyment of a stream in its natural flow, quantity, and quality. The lower riparian owners could join in one action two or more wrongdoers polluting a stream even though they were acting independently of each other in causing the injury. (Hubener-Florida)
W70-07134

06. WATER RESOURCES PLANNING

6A. Techniques of Planning

A STEADY STATE OPTIMAL DESIGN OF ARTIFICIAL INDUCED AERATION IN POLLUTED STREAMS BY THE USE OF PONTRYAGIN'S MINIMUM PRINCIPLE,
Rutgers - The State Univ., New Brunswick, N.J.; and Electronic Associates, Inc., Princeton, N.J.
For primary bibliographic entry see Field 05F.
W70-06743

THE INTEGRATED USE OF GROUND AND SURFACE WATER IN IRRIGATION PROJECT PLANNING,
Harvard Univ., Cambridge, Mass. Center for Population Studies.
For primary bibliographic entry see Field 03F.
W70-06837

THE KINEMATIC CASCADE AS A HYDROLOGIC MODEL,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 02A.
W70-06843

COMPUTER AIDED DESIGN OF WASTE COLLECTION AND TREATMENT SYSTEMS,
Michigan Univ., Ann Arbor.
Rolf A. Deininger.

In: Proceedings of the Second Annual American Water Resources Conference, American Water Resources Association, Urbana, Ill., 1966. p 247-258.

Descriptors: *Waste treatment, *Wastes, *Digital computers, *Optimization, Sewers, Topography, Flow, Costs, Regions, Linear programming.
Identifiers: *Waste collection, *Automatic design, Trunk sewers, Regional treatment, Nonlinear programming, Automatic plotting, Time-sharing computer systems.

This paper describes and summarizes research which has been carried out at the University of Michigan in an effort to define the feasibility and limitations of the use of digital computers in the automatic design of waste collection and treatment systems. Several separate topics were investigated. The first one deals with the optimal design of a trunk sewer. Given information about the topography, flows, costs of pipe and excavation, the problem of determining a minimum cost trunk sewer is cast as a non-linear programming problem, which by suitable approximations, can be restated as a linear programming problem. The second area of research is concerned with the problem of regional treatment systems. The decrease in per capita costs with increasing size of plant or sewer system is known and the mathematical pro-

gramming problem is one of simultaneously minimizing the cost of waste collection and waste treatment. The problem is shown to be of the form of a general network problem. Approaches for a solution are indicated. The third area of research is concerned with the design of a treatment plant in conversational form on a time-share computer system and the use of automatic plotting equipment for generating construction plans of treatment plants. (Richmond-Chicago)
W70-06849

EFFICIENT MANAGEMENT POLICIES FOR URBAN WATER SUPPLY,

Cornell Univ., Ithaca, N.Y. Water Resources and Marine Sciences Center.

David J. Allee.

Remarks at the Spring 1970 Conference, 'Water in an Urban Environment' sponsored by the American Society of Engineers at Catholic University, Washington, D.C., 31 March 1970. Typescript, 17 p.

Descriptors: *Economic efficiency, *Management, *Administration, *Inter-agency cooperation, Efficiencies, Water supply, Costs, Benefits, Economics, Political aspects, Political constraints, Institutional constraints, Welfare (Economics).
Identifiers: *Management policies, *Urban water supply, *Cost-sharing.

An attempt is made to spell out the difficult conditions faced by urban water supply managers in the past as they have attempted to achieve overall efficiency. Based upon this discussion, strategies formulated by a blending of economic and political concepts are suggested which could lead to higher levels of social efficiency in the future. Efficiency of an urban water supply is defined from a welfare economics viewpoint: It would be a water supply system where no change in delivery capacity or usage pattern can be made where the total value of the gain, or the benefits, caused by the change exceed the value of the corresponding losses or costs. The various assumptions necessary to this definition are discussed as well as the two factors which summarize the difference between this hypothetical statement and reality. First, responsibility for water supply has tended to have been delegated to special agencies. Second, there is a tendency toward geographic and institutional fragmentation of political constituencies. Several possible federal strategies are suggested: (a) sharing the burden of planning and development with local agencies, (b) inter-agency cooperation at the federal level, (c) more effective use of federal funds, and (d) a direct federal role in the actual operation of a regional agency. (Davis-Chicago)
W70-06929

THE ECONOMIC IMPACT OF DROUGHT ON WATER SUPPLY SYSTEMS IN THE PASSAIC RIVER BASIN, NEW JERSEY,
New Jersey Agricultural Experiment Station, New Brunswick.
For primary bibliographic entry see Field 05D.
W70-06960

OPTIMUM DESIGN OF COMPLEX WATER RESOURCE PROJECTS,
Rand Water Board, Johannesburg (South Africa).
David Stephenson.
ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY6, Paper 7320, p 1229-1246, June 1970. 18 p, 6 fig, 3 tab, 5 ref, append.

Descriptors: *Reservoir design, *Optimization, *Frequency analysis, *Draft-storage curves, *Linear programming, Reservoir storage, Water resources development, Operations research, Systems analysis, Mathematical models.
Identifiers: South Africa.

Permissible draft from reservoirs is related to reservoir capacity by draft-storage-frequency analysis and the resulting draft-storage curves are expressed

in algebraic form suitable for the optimum design of the reservoir system by linear programming. The curves are general and can apply to a number of reservoirs together. The principle of decomposition of linear programs is used to divide complex systems into projects, at the same time considering interbasin links. The river basins are then optimized using operations research techniques on individual basins or projects. A mathematical model of the Vaal and Tugela river basins in South Africa is used as an example. (Knapp-USGS)
W70-06980

SYNTHESIS OF URBAN RAINFALL,

Auckland Univ. (New Zealand).

A. J. Raudkivi, and N. Lawgun.
Water Resources Research, Vol 6, No 2, p 455-464, April 1970. 10 p, 4 fig, 7 tab, 3 ref.

Descriptors: *Statistical models, *Computer models, *Synthetic hydrology, *Simulated rainfall, *Depth-area-duration analysis, Statistical methods, Time series analysis, Mathematical models, Correlation analysis, Markov processes, Stochastic processes, Rainfall, Precipitation (Atmospheric), Cities, Urbanization.
Identifiers: Urban rainfall.

A statistical analysis of rainfall records is used to develop a computer model for generation of a sequence of short period rainfalls. The time intervals between rainfalls are generated by sampling from a frequency distribution fitted to the historical data. The model also uses a first order Markov process in addition to random sampling from a frequency distribution, to obtain the rainfall durations. Rainfall depths are obtained by sampling from the joint distribution of rainfall depths and durations. Model parameters are based on the meteorologic conditions of the Auckland area, and all statistical tests were performed at a 5% level of significance. The model produces comparable time intervals between storms and a linear correlation between rainfall depths and durations, but extreme values of rainfall depths and durations are absent from the generated data. (Knapp-USGS)
W70-06992

A FACTOR ANALYSIS OF RESERVOIR LOSSES,

Agricultural Research Service, Riesel, Tex. Soil and Water Conservation Research Div.
For primary bibliographic entry see Field 04A.
W70-06997

RECURRENCE INTERVALS BETWEEN EXCEEDANCES OF SELECTED RIVER LEVELS 3. ESTIMATION AND USE OF A PRIOR DISTRIBUTION,

New South Wales Univ., Kensington (Australia). Dept. of Statistics; and Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.
For primary bibliographic entry see Field 02E.
W70-06998

STATISTICAL ASPECT OF THE PROBLEM OF PERMEABILITY OF FISSURED ROCKS,

For primary bibliographic entry see Field 02F.
W70-07088

6B. Evaluation Process

A METHOD TO ANALYZE THE EFFECTS OF FLUCTUATION RESERVOIR WATER LEVELS ON SHORELINE RECREATION USE,

Waterloo Univ. (Ontario). School of Urban and Regional Planning.
Reiner Jaakson.
Water Resources Research, Vol 6, No 2, p 421-429, April 1970. 9 p, 3 fig, 3 tab, 1 ref.

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Descriptors: *Reservoirs, *Water level fluctuations, *Recreation, Costs, Multiple-purpose reservoirs, Flood control, Planning, Water management (Applied), Reservoir operation, Reservoir design, Economics, Cost-benefit analysis.
Identifiers: Shoreline recreation.

A direct relationship exists between reservoir water level fluctuations and shoreline recreational quality. An increasing acknowledgment that recreation is one of the more active basic economic factors of regional growth has helped to justify the maintenance of constant, or near constant, levels during the recreation season. A methodology is presented whereby the optimum water level for a reservoir can be identified, based on an analysis of recreation potential of the shoreline at different lake levels. Applications of the methodology also assess shoreline damages due to flood levels. A shoreline inventory taken before a major flood may be compared to an inventory taken after the flood; differences in physiographic rates illustrate the loss of shoreline use due to erosion, to loss of tree cover, and to change of beach materials. Further uses of the methodology include economic comparisons of the value of maintaining constant lake levels with the value of maintaining flood storage levels. Dollar values attached to shoreline rates provide an estimate of the loss of shoreline use due to flood storage levels, which may be compared with the benefit of flood prevention in the floodplain of an adjoining river basin. (Knapp-USGS)
W70-06742

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOLUME II, APPENDIX.

Federal Water Pollution Control Administration, Washington, D.C.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price \$4.75. FWPCA Report, Jan. 10, 1969. 541 p, 1 map.

Descriptors: *Economic impact, *Water costs, Investment, Interest rate, Replacement costs, Sewerage treatment, Depreciation, Operating costs, Maintenance costs, Industrial wastes, Thermal pollution, Pesticide residues, Soil contamination.
Identifiers: *Federal Water Pollution Control Act.

This is the appendix to Vol. 1, of the Report series. The appendix contains summary tables on the United States, tables of each state, major basin tables, state agency comments, and industrial organization comments. The tables cover the following areas: (1) 1962 municipal waste inventory, (2) contract awards 1962-1967, (3) 1968 municipal waste inventory; (4) ratio of design loading to domestic loading, (5) ratio of indicated loading to domestic loading; (6) joint treatment facilities; and (7) implementation plans summary. A glossary of terms is included. (See also W70-06840) (Grossman-Rutgers)
W70-06839

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOLUME III, (SEWERAGE CHARGES).

Federal Water Pollution Control Administration, Washington, D.C.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price \$1.75. FWPCA Report, Jan. 10, 1969. 103 p, 19 tab, 64 ref.

Descriptors: *Economic impact, *Water costs, Investment, Interest rate, Replacement costs, Sewerage treatment, Depreciation, Operating costs, Maintenance costs, Industrial wastes, Thermal pollution, Pesticide residues, Soil contamination.
Identifiers: *Federal Water Pollution Control Act.

This volume covers the current position of user charges, types of user charges, division of cost responsibility between users and nonusers, allocation theories, and the distribution of cost responsibility among categories of users. An appendix of sewerage charges in each state is included. (See also W70-06841) (Grossman-Rutgers)
W70-06840

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOL. IV. PROJECTED WASTE WATER TREATMENT COSTS IN THE ORGANIC CHEMICALS INDUSTRY.

Rice (Cyrus Wm.) and Co., Pittsburgh, Pa.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price \$1.75. FWPCA Report, June 1968. 191 p, 28 tab, 45 fig, 4 append, 73 ref.

Descriptors: *Pollution abatement, *Waste water treatment, *Costs, Chemical wastes, Treatment facilities.
Identifiers: *Organic chemical industry.

An estimate of the costs that would be incurred by the organic chemicals industry in attaining various levels of pollution abatement over a five-year period is presented. Also included is a generalized methodology by which similar continuing estimates can be made for other water-using industries. Cost estimates are derived from published data, general data derived from information in the files of the author, companies on industrial waste treatment and costs, and specific data from 54 organic chemical plants. The total costs given in this report are for the construction and operation of waste treatment facilities for the industry as a whole. Projections as to various aspects of the organic chemicals industry are estimated for 1969 and projected for 1973 are included. The appendices contain the data form utilized in the study, survey data, petrochemical industry product profiles, and costs of unit waste water treatment practices. (See also W70-06838) (Grossman-Rutgers)
W70-06841

WATER AND ESTHETICS IN THE LOWER COLORADO RIVER BASIN,

Sierra Club, San Francisco, Calif.

David R. Brower.

In: Proceedings of the Second Annual American Water Resources Conference, American Water Resources Association, 1966, p. 134-142, 32 ref.

Descriptors: *Reclamation, *Conservation, *Political aspects, Water supply, Water transfer, Economics, Silt.

Identifiers: *Grand Canyon, *Grand Canyon National Park, *Grand Canyon National Monument, *Bureau of Reclamation, *Sierra Club, *National Reclamation Association, *Reclamationist, *Conservationist, *Special-interest groups, *Esthetics.

As a member of the Sierra Club, the author pleads for the protection of the Grand Canyon National Park and National Monument which is threatened by the National Reclamation Association and Bureau of Reclamation's proposal to build a series of dams in the canyon. He deals with the matter of water supply by illustrating the area's inefficient use of water. He argues that the Hoover Dam is a more efficient supplier of cash reserves than the proposed dams. He debates the claim that the new revenues provided are needed to finance the importation of water, noting that this far off plan may not come to fruition. In answer to the claim that the Grand Canyon would be enhanced and not flooded out, he argues that 148 miles of living river would be destroyed and that 105 miles of canyon would be made inaccessible. He supports alternate financing of water development, citing TVA support of nuclear power plants in that coal rich area. The reclamationist proposal claimed that such an arrangement was nonsense. He debates the reclamationist claim of preparing for the future water uses by disagreeing that such a need will actually

develop. He makes a plea for public support, pointing out that once this land is lost to reclamation, it cannot be recovered. (Richmond-Chicago)
W70-06847

THE INCREASING IMPACT OF RECREATION ON WATER RESOURCES PLANNING,

California State Dept. of Water Resources.

Reginald C. Price.

In: Proceedings of the Second Annual American Water Resources Conference, American Water Resources Assn., Urbana, Ill., 1966, p 187-92.

Descriptors: *Recreation demand, *Recreation, *Recreation facilities, *Multiple-purpose reservoirs, *Financing, *California, *Planning, *Water resources development, *Social values, *Evaluation, *Interagency cooperation, Water pollution effects, *Urbanization, Benefits, Economic impact, Boating, Fishing, Camping, Hunting, Swimming, Wildlife.

Identifiers: *Leisure, *Trice-Wood method, *Intergovernmental cooperation, *Comprehensive planning, Recreational opportunities.

The author emphasizes the tremendous growth of water-oriented recreation. This growth is seen as a result of increased leisure time and personal income combined with the desire to escape from urban areas for some part of the year. To meet these needs, which will continue to increase at an even greater rate in the next 50 years, multiple-purpose water resources projects must be designed. In addition, older projects which did not consider recreational benefits must be altered to help meet the recreation demand. As such, recreation has had a tremendous impact on planning. New methods of project evaluation such as California's Water Resources Department's Trice-Wood method have been developed in response. More sophisticated approaches, as suggested in Senate Document No. 97 are now being developed. In addition, cooperation between and within, Federal, state and local governments is also necessary if a coordinated comprehensive water resources planning approach is to be achieved. The Federal Water Recreation Act (1965) is seen as a step toward such an achievement. A short case history of the Auburn-Folsom South Unit of the Central Valley Project of California is included. (Richmond-Chicago)
W70-06850

TRENDS IN SMALL BOATING AND ITS IMPACT ON WATER RESOURCES DEVELOPMENT,

Boating Industry Association.

Fred B. Lifton.

In: Proceedings of the Second American Water Resources Conference, American Water Resources Assn., Urbana, Ill., 1966, p 182-86.

Descriptors: *Boating, *Recreation, *Recreation demand, *Recreation facilities, Water pollution effects, *Water pollution control, *Water pollution, *Financing, *Economic impact, *Economics, Reclamation, Multiple-purpose reservoir, Channel improvement, Locks, Federal government, State governments, Local governments.

Identifiers: *Research needs, *Unfunded gasoline taxes, *Federal Land and Water Conservation Act, Fun and sun-seeking enthusiast.

The author is a spokesman for the manufacturers of recreational boating materials. He points out the nation's growing interest and participation in water recreation activities. The need for more facilities near metropolitan population centers is discussed. It is suggested that such needs could be met by enforcing strict pollution control measures on polluters, thereby reclaiming waterways and lakes in urban areas. At the same time, the water would have to be cleaned, channels dredged and some locks and dams constructed. The author suggests that these tasks could be financed from the un-refunded gasoline taxes which presently amount to \$100 million. He cites the passage of the Federal Land and Water Conservation Fund Act (1964) as

a step in the right direction, even though much of the monies spent do not go to water-oriented recreation. Finally, he states that governmental support cannot be justified by recreational needs alone. To this end he points out that many areas have undergone economic rejuvenation as a result of flood control and power projects. Research to document the nature and magnitude of these benefits is called for with the suggestion that the Federal government do the actual research. (Richmond-Chicago)
W70-06851

DEVELOPMENT BENEFITS OF WATER RESOURCES INVESTMENTS.

Washington Univ., St. Louis, Mo.

Charles L. Leven, Editor. Corps of Engineers, Institute for Water Resources. Report IWR 69-1, Alexandria, Virginia, Nov. 1969, 443 p, 7 fig, 97 tab, 133 ref. Contract Number DA 49-129-CIVENG-66-11.

Descriptors: *Indirect benefits, *Methodology, Economics, Regional analysis, Theoretical analysis, Data processing, Analytical techniques, Model studies, Federal project policy.

The project focuses on the question of determination and evaluation of developmental benefits of water resource investments. It recognizes that, in addition to the value of water resource services to service users (primary benefits), water resource investments might enhance a region's economy (secondary benefits). The central problem of the project is to evaluate the national and interregional consequences of exogenous change in a single region. Solution of that problem requires new theoretical formulations, new analytical techniques, and unconventional kinds and combinations of data. Analysis of primary benefits remains unchanged. This report provides some of the needed reformulations in regional development theory and develops practical operational analyses. It recommends particular revisions in present Corps evaluation procedures. The report consists of four sections: (1) overview of the project; (2) development of theory; (3) descriptions of analytical models; and (4) description of purposes and present evaluation procedures, with some suggestions for alterations. Each section includes two or more chapters. (See also W70-06854 thru W70-06861) (Gossen-Chicago)
W70-06853

CHAPTER 1: THE PROBLEM.

Washington Univ., St. Louis, Mo.

In: Development Benefits of Water Resources Investments. U.S. Army Institute for Water Resources, Alexandria, Virginia, Nov., 1969, p. 1-17, 1 fig.

Descriptors: *Indirect benefits, *Methodology, *Economics, Regional analysis, National income, Evaluation, Cost-benefit analysis, Direct benefits, Human population, Water supply, Administrative agencies.

Chapter 1 discusses: the nature of the problem of determining developmental, or secondary benefits; the methodology developed to solve this problem; and why the chosen methodology was adopted. Developmental effects are triggered by any of three kinds of reactions to water resource investments: (1) when economic activities which might not otherwise occur in the area, locate there in response to the enhancement of its water resources; (2) when non-residents come to the area for recreation; (3) when individuals move to the area because of its water resources development. Any of these developments in one area necessarily has consequences for economic activity levels in other areas. These consequences and over-all effects on the national economy must be determined. The first difficulty in this determination is that developmental effects cannot be thought of as a

number. The second complication is that the distribution of effects by region depends on the way regions are defined. The analyses developed in this study are useful to primary benefit evaluation in two ways: (1) by computing regional distribution of population as an independent variable; and (2) by recognizing that water availability affects population. Organizational implications for the Corps are discussed. (See also W70-06853) (Gossen-Chicago)
W70-06854

CHAPTER 2: APPROACHES TO A SOLUTION.

Washington Univ., St. Louis, Mo.

In: Development Benefits of Water Resources Investments. U.S. Army Institute for Water Resources, Alexandria, Virginia, Nov., 1969, p. 18-46, 1 fig.

Descriptors: *Methodology, Indirect benefits, Regional analysis, Water costs, Water quality, Water supply, Employment, Recreation facilities, Economic impact, Construction costs, Navigation, Input-output analysis, Model studies, Taxes, Transportation.

Identifiers: General equilibrium effects, Agglomeration effects.

Chapter 2 discusses two stages of analysis in determining developmental effects. The first stage, developed by the University of Chicago, includes changes in cost, quality, and availability of water resource services explicitly as independent variables. It determines the following relationships: (1) employment and output as a function of the cost, quality, or availability of water; (2) utilization of recreation facilities as a function of their scale and characteristics; (3) volume of economic activities involved in constructing water resource projects as a function of their scale and characteristics; and (4) cost of water transportation as a function of navigational properties of waterways. The second stage, developed by Washington University, determines general equilibrium effects. The approach used is a conventional regional input-output analysis, extended by making calculations to a fuel interregional interindustry format and by adding models to: (1) determine agglomeration effects; (2) estimate the impact of interregional changes in activity on state tax avenues; and (3) estimate consequences of regional reallocations of economic activities for the use of transport inputs. The scope, form, and necessary limitations of both stages of analysis are discussed. Complications inherent in the first stage are analyzed. (See also W70-06853) (Gossen-Chicago)
W70-06855

CHAPTER 3: A MODEL OF DIFFERENTIAL REGIONAL GROWTH.

Washington Univ., St. Louis, Mo.

In: Development Benefits of Water Resources Investments. U. S. Army Institute for Water Resources, Alexandria, Virginia, Nov., 1969, p 47-66, 7 ref.

Descriptors: *Mathematical models, *Methodology, *Economic prediction, Human population, Employment, Labor supply, Labor mobility, Capital supply, Regional analysis, Migration, Wages.

Identifiers: Export-base theory of forecasting, Borts-Stein theory, Export demand.

Chapter 3 discusses the problem of predicting future population and employment. Section I discussed past theories of forecasting. Most theories are based on the export-base theory. Borts and Stein, however, suggest: (1) that differential changes in manufacturing employment result from differential shifts in labor supply to a region's manufacturing sector; and (2) that the demand for a region's exports and its supply of capital are infinitely elastic. Section II demonstrates the appropriateness of the Borts-Stein theory to a developmental situation. Sections III and IV, the

major sections of the chapter, describe the model and formulate it mathematically. The model determines employment change and migration simultaneously. The dependence of migration on the change in employment has two causes: (1) firms wishing to expand employment in a particular community may transfer workers from other places; and (2) migrants may be attracted to areas where employment is growing relative to the labor force. Differential changes in wage rates, and effects on total regional employment of changes in exportable sector demand and in labor supply are determined by the Borts-Stein approach. Section IV formulates the model as a system of eight simultaneous structural equations in eight endogenous variables. (See also W70-06853) (Gossen-Chicago)
W70-06856

CHAPTER 4: THE REGIONAL GROWTH MODEL AND EMPIRICAL ANALYSIS.

Washington Univ., St. Louis, Mo.

In: Development Benefits of Water Resources Investments. U.S. Army Institute for Water Resources, Alexandria, Virginia, Nov., 1969, p. 67-106, 5 tab, 17 ref.

Descriptors: *Methodology, *Mathematical models, Data processing, Statistical models, Economic prediction, Employment, Migration, Wages.

Identifiers: *Empirical testing.

Chapter 4 subjects the regional growth model to empirical analysis, using twenty-five cities for test studies. Section I describes the nature of the data used as empirical measures of the model's variables, the time period and areal units for which these measures were obtained, and discusses the selection of predetermined variables. Using this data, Section II discusses the model's estimates of the employment change and migration equations. Section III discusses the estimates of the model's other equations. These two sections focus on the statistical features of the estimates. Section IV considers some of their economic implications. The empirical results support the hypothesis that money wage rates are exogenously determined by firms selling their outputs and buying non-labor inputs in national markets. Results cast doubt on the hypothesis that employment change is exogenously determined and that wage rigidities or other labor market imperfections limit the availability of jobs. It appears that migration is not importantly affected by firms transferring or hiring workers in other places. (See also W70-06853) (Gossen-Chicago)
W70-06857

CHAPTER 7: SOME APPLICATIONS.

Washington Univ., St. Louis, Mo.

In: Development Benefits of Water Resources Investments. U.S. Army Institute for Water Resources, Alexandria, Virginia, Nov., 1969, Contract Number DA 49-129-CIVENG-66-11, p. 217-280, 26 tab.

Descriptors: *Mathematical models, *Methodology, *Economic prediction, Regional analysis, Employment, Recreation, Industries.

Identifiers: *Youghiogheny Reservoir Area.

Chapter 7 discusses model-derived results for a prospective project in the Youghiogheny Reservoir Area (YA) and describes how they were obtained. The analysis depends on interregional location and interregional impact models developed in previous chapters and on results from a separate University of Chicago study. Estimates are derived: (1) of the impact of the project on employment in each of the five major water-using industries in YA; and (2) of additional user-days of recreation in YA resulting from the project. Section I transforms projections of employment estimates for water-using industries into a form suitable for estimating interregional-inter-industry impacts. The process is mainly application of an interregional location model. Section

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II outlines the computation procedure. Section III describes the modifications and format needed to fit the recreation-use estimates into the interregional-interindustry model. The final section discusses the interregional-interindustry calculations and presents the results of those calculations. For 23 industries in 3 regions, changes are shown in activity levels of water-using industries, of recreation-oriented activity, and of both combined. (See also W70-06853) (Gossen-Chicago)
W70-06858

CHAPTER 9: OBJECTIVES AND PRESENT PRACTICES IN EVALUATION OF WATER RESOURCE PROJECTS.

Washington Univ., St. Louis, Mo.

In: Development Benefits of Water Resources Investments. U.S. Army Institute for Water Resources, Alexandria, Virginia, Nov., 1969, p. 324-370, 40 ref.

Descriptors: *Economic justification, *Federal project policy, History, Water resources, Planning Act, Project planning, Water quality control, Erosion control, Flood control, Recreation, Benefits, Costs, Cost-benefit ratio.

Identifiers: Senate Document 97, Congressional project selection, Water supply control.

Deriving an optimum investment policy would require exact welfare function specification. Pursuing such an objective function is beyond the scope of the study, but a formal statement of evaluation procedures is provided in Chapter 9, along with a description of policy objectives. Section I considers the scope and objectives of federal water resource policy over time. Sections II and III analyze Senate Document 97 and the Water Resources Development and Planning Act. Together these two documents represent the current federal water resources policy. Section IV examines the Congressional record of project selection. Section V initiates an attempt by succeeding sections to summarize the most important elements of present practices in economic evaluation on the basis of policy statements, technical manuals and selected project reports. Section VI discusses four categories of water resources control: (1) water supply and quality control; (2) prevention of soil erosion; (3) flood control; and (4) recreation uses. Section VII describes general principles of project formulation. Sections VIII and IX evaluate benefits and costs. Section X comments on integrating projects with plans and on the economic bias of excess benefits. (See also W70-06853) (Gossen-Chicago)
W70-06859

CHAPTER 10: SOME ISSUES IN PRESENT PRACTICES OF PROJECT EVALUATION.

Washington Univ., St. Louis, Mo.

In: Development Benefits of Water Resources Investments. U.S. Army Institute for Water Resources, Alexandria, Virginia, Nov., 1969, p. 371-443, 2 fig, 19 tab, 28 ref.

Descriptors: *Federal project policy, Investment, Cost-benefit ratio, Interest rate, Evaluation, Costs, Benefits, Theoretical analysis, Appropriation.

Identifiers: Internal rate of return, Social costs, Distribution of benefits.

Three issues are discussed: (1) should federal projects be selected on the basis of maximum benefit-cost ratio or internal rate of return on invested funds; (2) at what rate of interest are future benefits discounted to the present; and (3) according to what principles are costs and benefits actually evaluated. Section I shows that benefit-cost analysis is ordinarily the preferred criterion for public investment and that it is a feasible alternative to the rate of return criteria. The theoretical superiority of benefit-cost analysis is proven. However, for benefit-cost analysis to be used, an interest rate must be found which is stable and which accurately reflects the social cost of capital. Sec-

tion II argues that such an interest rate can be established. Section III analyzes present evaluation practices of the Corps of Engineers, and shows that distributional effects are inadequately considered. The final section suggests two methods of accounting for distributional effects, and recommends that the Legislature announce to the Corps what distributional weights it wishes the Corps to assign. This action would explicate the value system implicit in the appropriation process, thereby reducing the uncertainty of the sequence in which projects will be funded. (See also W70-06853) (Gossen-Chicago)
W70-06860

DEVELOPMENT BENEFITS OF WATER RESOURCES INVESTMENTS (APPENDICES).

Washington Univ., St. Louis, Mo.

Charles L. Leven (editor). Corps of Engineers, Institute for Water Resources Report IWR 69-1, Alexandria, Virginia, November, 1969, 310 p. Contract No. DA 49-129-CIVENG-66-11.

Descriptors: *Indirect benefits, *Methodology, Economics, Regional analysis, Theoretical analysis, Data processing, Analytical techniques, Model studies, Federal project policy.

Contents: Appendix A, The Efficacy of Labor Migration with Special Emphasis on Depressed Areas; Appendix B, The Influence of Community Characteristics on the Relationship of Unemployment Changes to Employment Changes in Major Labor Market Areas; Appendix C, Programs for Computerized Location Models for Assessing Regional Shifts in Industrial Location; Appendix D, Economic Base and Input-Output Models and Their Role in Regional Analysis; Appendix E, Mathematical Derivation of the Interregional Input-Output Model; Appendix F, Area Definition; Appendix G, Industrial Definition; Appendix H, Wholesale Sector Survey; Appendix I, Combination Transforms for the Aggregation of Interregional Commodity Flows; Appendix J, Interindustry Analysis Tables for Appalachia, Ozarka and Rest of the United States; Appendix K, Regional System B; Appendix L, Regional System C; Appendix M, Outputs of Computerized Location Model; Appendix N, Users of Youghiogheny Recreation Facilities by State and County of Residence; Appendix O, Programming Statement for Pilot Area Impact Solutions; Appendix P, Testing for Constancy Over Time of the Elasticities; Appendix Q, Method of Progressive Refinement and Narrowing of the Field of Choice. (See also W70-06853)
W70-06861

DEVELOPMENT OF THE CONCEPT OF COMPREHENSIVE WATER RESOURCES PLANNING.

Virginia Polytechnic Inst., Blacksburg. Dept. of Civil Engineering.

Frederick E. McJunkin.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec. 1-3, 1965, Urbana, Illinois, p 106-119, 74 ref.

Descriptors: *Federal project policy, *Institutional constraints, History, Legislation, *Water resources development, *Multiple purpose projects, Tennessee Valley Authority Project, Project purposes.

Identifiers: *Comprehensive planning, *Gallatin Report, '308' Reports, Flood Control Acts, Inter-Agency River Basin Committee.

The development of the concept of comprehensive planning is reviewed to help the planner understand his institutional environment, especially those features which tend to restrict his activity. The concept had its genesis in 1808 in the Gallatin Report. In general, nineteenth century water resources development was largely concerned with navigation although elements of multipurpose development were forming by the end of the century. The conservation movement under Theodore

Roosevelt, the '308' Reports, and the work projects, Tennessee Valley Authority Act, Flood Control Acts, and Federal Inter-Agency River Basin Committee created during the depression and war years are discussed. The decade following World War II was fraught with controversy. From 1959 to 1961, the Senate Select Committee on National Water Resources worked to create a unified policy. Recent policy developments are largely legislative acts foreshadowed by the Report of the Select Committee. Comprehensive planning as presently conceived has three dimensions: (1) physical purpose; (2) basin scale; and (3) goals. The roots of most conflicts lie in the choice of goals. The article suggests that such conflicts are inevitable, accentuated by the multiplicity of agencies and statutory authorizations involved. (Gossen-Chicago)
W70-06931

TECHNIQUES IN THE APPLICATION OF ENGINEERING ECONOMY TO WATER RESOURCES DEVELOPMENT,

Kentucky Univ., Lexington. Dept. of Civil Engineering.

L. Douglas James.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec 1-3, 1965, Urbana, Illinois, p 120-127, 2 fig.

Descriptors: *Value engineering, *Decision making, Optimization, Competing uses, Economic feasibility, Evaluation, Investment, Costs, Benefits, *Project feasibility, *Project purposes, Intangible benefits, Intangible costs, Marginal benefits, Marginal costs.

An engineering economy procedure for investigation of the consequences of investment alternatives is described. Three questions must be answered for each alternative expenditure: (1) why do it at all; (2) why do it now; and (3) why do it this way. Answering the first two questions involves four steps: (1) define the nature and scope of the project and describe its beneficial and detrimental consequences; (2) convert consequences into commensurable units (dollar value), and tabulate consequences that cannot be assigned a monetary value; (3) use discounting to make monetary values at different times commensurable; and (4) compare the monetary values and tabulated intangibles of the various alternatives. The methods of measuring value and the kinds of research necessary to improve economic analysis vary with project purposes, seven of which are discussed: (1) flood control; (2) land drainage; (3) navigation; (4) hydroelectric power; (5) water supply; (6) recreation; and (7) water quality control. Answering the third question involves three steps: (1) select the optimum degree of service by equating marginal benefits and marginal costs; (2) select the optimum area served by separating those points with favorable benefit-cost comparisons; and (3) select the details of the optimum design to produce the desired output at the minimum cost. (Gossen-Chicago)
W70-06932

TRENDS IN PLANNING OF WATER RESOURCES PROJECTS,

Harza Engineering Co., Chicago, Ill.

V. A. Koelzer.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec 1-3, 1965, Urbana, Illinois, p 135-145, 1 fig, 1 tab, 1 ref.

Descriptors: *Project planning, *Methodology, Flexibility, Water supply, Water quality, Social change, City planning, Legislation, Water Resources Planning Act, Water Quality Act, Multiple purpose, *Project benefits, Evaluation, *Water resources development, Intangible benefits, Intangible costs.

Identifiers: *Trends, Comprehensive planning.

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Current trends in planning of water resources projects are described. Three factors seem to be causing the current changes: (1) a growing recognition of potential deficiencies in water quantity and water quality; (2) a radical change from a simple to a complex society, accompanied by growing affluence; and (3) a growing recognition by lower levels of government that they must accept their share of responsibility in water resources decisions. These three changes are reflected in changes in legislation and in the procedures used to plan water resources projects. The first three sections of the paper discuss the three factors of change. The remaining two discuss legislation and planning procedures. Important examples of recent legislation include the Water Resources Planning Act of 1965 and the Water Quality Act of 1965. The advantages of creating a national resources commission are considered. Societal and legal changes have created the following requirements for water resources planning: (1) comprehensive and multipurpose planning; (2) methods to evaluate project benefits; (3) new and imaginative ways to develop and control water resources; and (4) recognition of the uncertainties that exist in water resources planning. Inherent in all of these requirements is the ability to maintain flexibility in planning. (Gosse-Chicago)

W70-06933

COMPREHENSIVE RIVER BASIN PLANNING,
James S. King.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec 1-3, 1965, Urbana, Illinois, 1966, p 128-134, 2 ref.

Descriptors: *Decision making, *Methodology, Investment, *Competing uses, Short-term planning, Long-term planning, Multiple purpose, Inter-agency cooperation, Data collections, Legislation.

Identifiers: *River basin planning, *Comprehensive planning, Multiple means, Economic distribution, Decision-making criteria, Multiple-discipline planning, Research developments.

River basin planning is seen as a technique of public investment decision making to allocate resources among competing claims. In specific plans, the goal is to provide the best use, or combination of uses, of water and related land resources to meet all foreseeable short- and long-term needs. To this end, all relevant means, singly, in combination, or in alternative combinations, reflecting different basic choice patterns, must be used. The body of the paper describes the analyses necessary to create such alternatives. Nine guideposts for decision making are discussed: (1) analyses should be accomplished within the context of total investment planning for all sectors of the economy; (2) pure economic efficiency is not necessarily the predominant criterion for determining the scope of investment; (3) all effects and all persons or groups affected must be considered; (4) planning must involve experts in several disciplines; (5) inter-agency cooperation is essential; (6) decisions must be based on adequate data; (7) engineers must strive to understand basic water laws and authorities; (8) individual projects cannot realize optimum benefits without an overall plan for the basin; and (9) analyses should reflect the advantages of the many recent developments in the planning process. (Grossen-Chicago)

W70-06934

RECREATION IN WATER RESOURCES DEVELOPMENT,
Resources for the Future, Inc., Washington, D.C.
For primary bibliographic entry see Field 06D.

W70-06936

THE EMBATTLED COLOSSUS: NEW YORK CITY WATER SUPPLY SYSTEM, ITS PAST, PRESENT, AND FUTURE,
New York City Environmental Protection Administration.
For primary bibliographic entry see Field 03D.

W70-06939

WATER FOR CITIES,
Corps of Engineers, Washington, D.C.
William F. Cassidy.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 34-41.

Descriptors: *Water supply, *Decision making, *Interstate compacts, Interstate commissions, *Planning, *Coordination, *Institutions, *Technology, Organizations, Water quality control, Waste water treatment, Storage, Inter-basin transfers, Multiple-purpose project.

Solutions to the problem of city water supplies will be found in three main areas of endeavor: Careful comprehensive planning; coordination between affected organizations and interests; and the selection or creation of institutions to carry out the work. It is suggested that the tendency to think of city and country as separate or opposed is going to be a major problem. Technological means of dealing with water supply factors—quantity, quality, time, and place—are reviewed. The use of storage facilities for time considerations, the use of large-scale interbasin transfers of water for place considerations, and means of managing waste water to increase quantity are mentioned. Technological inadequacies in improving water quality is suggested as being correctable by treatment at the source. Planning considerations are reviewed and indicate the need for providing institutions through which decision making can take place. Conflicting priorities in the allocation of limited water availability, and the need for multipurpose programs and multidisciplined approaches are pointed out. Experiences in Basins are reviewed in terms of their coordination and levels of comprehensive participation. Among several institutions thought to be effective in meeting these needs are: the interstate compact providing for the interstate commission; the federally created entity governed by a federally appointed commission, and the State Water plan involving interchanges between several intra-State river basins. (Preckwinkle-Chicago)

W70-06940

METROPOLITAN AREA WATER RESOURCE PROBLEMS,

Rutgers - The State Univ., New Brunswick, N.J.
Water Resources Research Inst.

William Whipple, Jr.
Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 42-50, 9 ref.

Descriptors: *Water resources development, *Planning, *Intangible costs, *Attitudes, *Coordination, *Urbanization, *Economic efficiency, *Systems analysis, Delaware River Basin Commission, Waste identification, Standards, Waste treatment, Flood plains.

Identifiers: *Interdisciplinary planning, Ruhr agencies.

Former resource development projects by the federal government have placed the control of nature as their primary importance, but in metropolitan areas conditions are forcing a reconsideration of the traditional engineering approach. Development in flood plains becomes a more urgent problem with space as a premium; and the 'economic efficiency' approach to planning is being increasingly challenged by other objectives such as maximizing income redistribution. Systems analysis and interdisciplinary planning are important new ideas, however, there are dangers in trying to quantify intangibles or being unduly impressed with what a computer is capable of doing. Interdisciplinary planning must first set down which functions the various fields focus upon. Plans allowing for both flexibility and maintenance of standards are suggested with increasing use of advanced computational techniques, increased interagency and

inter-interest coordination in preliminary and final stages of planning, greater consideration of intangibles and public attitudes, and a gradual increase in the number of social scientists involved. The existence of major unrecorded waste sources combined with the diversity of known sources add to enforcement difficulties. Federal expenditures and policies against evaluating clean water in economic terms are questioned. Similarly, problems in unifying all water resources planning and management into a single process are mentioned. The Delaware River Basin Commission and the Ruhr agencies in Germany are mentioned as meeting new organizational problems. (Preckwinkle-Chicago)

W70-06941

WATER RESOURCES PLANNING FOR MULTIPLE OBJECTIVES,

Corps of Engineers, New York. North Atlantic Div.
Harry E. Schwarz.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 183-189, 2 fig.

Descriptors: *Planning, *Watershed management, State governments.

Identifiers: *Multiple objectives, *Corps of Engineers, *Environmental quality, *Regional development, *National efficiency, *Needs, *Resources.

The needs of people must be held at the forefront of all planning processes. Experimentation by the Corps of Engineers has involved multiple-objective planning aimed at closing the 'information-gap' in basin planning, and making choices explicit. Three objectives are mentioned for the North Atlantic Region: environmental quality, regional development, and national efficiency. Explanations of each objective and reasons for selecting them are given; a schematic representation indicates how combinations of the objectives can be devised. In focusing on one objective the fulfillment of some portion of the other objectives cannot be overlooked. Careful consideration of objectives and possible technical or institutional alternatives is stressed. Plan formulation is to be carried out by a work group bringing together specialists from all states and from the Federal agencies concerned. Formulation of plans involves relating three components: needs or demands, resources, and devices. These components are defined with two groups of devices distinguished, active devices and passive devices. Active devices change or manage resources to fill demands and passive ones effect the demands so that existing resources suffice. A three-dimensional matrix can be constructed to show the interrelations of all the components; and it is suggested that there is a unique point for each combination of the three. This matrix is then related back to the multiple objectives scheme to show their workability together. (Preckwinkle-Chicago)

W70-06944

REGIONAL PLANNING AND FLOOD PLAIN MANAGEMENT,

Pennsylvania State Planning Board, Harrisburg, Pa.
For primary bibliographic entry see Field 06F.

W70-06945

COMPREHENSIVE FLOOD PLAIN MANAGEMENT REQUIRES BLENDING OF TECHNOLOGY AND SOCIAL FACTORS,

For primary bibliographic entry see Field 06F.

W70-06946

CITIZEN ACTION IN WATER,
Trinity River Authority of Texas, Arlington.
David H. Brune.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 296-303.

Field 06—WATER RESOURCES PLANNING

Group 6B—Evaluation Process

Descriptors: *Water resources development, *Projects, *Technical societies.
Identifiers: *Citizen action, *Information groups, *Citizen voter, National Rivers and Harbors Congress, National Reclamation Association, Sierra Club, De Witt-Gonzales River Association, San Antonio Conservation Society.

With the assumption that an active, well-informed citizenry is the key to future development of America's water resources, the author touches upon four areas in which there is or should be citizen action in water. The first of these considers the citizen as member of an organized group and here four distinct directions are perceived: groups affirmatively supporting water resources development programs, groups opposing specific projects, technical groups, and information groups. Examples are outlined for each of these with short descriptions. Extended attention is given to one of the groups opposing specific projects—the De Witt-Gonzales River Association—especially with regard to the way its appeal is presented. The San Antonio Conservation Society is viewed in contrast to be directed toward positive goals with 'reasonable considerations' in its opposition. The second area of citizen participation is as a member of a governing body of a governmental entity. No specific illustrations are given but the need to evaluate alternative solutions and make policy decisions based on a wide spectrum of factors summarized in the term 'public interest' is emphasized. The third area of participation is as a voter and four categories of elections are brought up: election of public officials, approval of water supply contracts, approval of Ad Valorem taxes, and approval of bond issues. The final area involves the citizen as the person who pays the bill, and emphasis is placed on fully informing the public. (Preckwinkle-Chicago)
W70-06949

CITIZEN ACTION IN WATER--ASSET OR LIABILITY,

Water Resources Association of the Delaware River Basin, Philadelphia, Pa.

Paul M. Felton.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 304-309.

Descriptors: *Delaware River Basin Commission, *Conservation, *Water resources development.
Identifiers: *Citizen action, *Delaware river basin, *Water Resources Association of the Delaware River Basin, Delaware Valley Conservation Association, Single-purpose associations, Multi-purpose planning, Comprehensive planning.

Citizen action in the Delaware basin is described with illustrations of 'the good and bad sides' and it is left up to reader to decide whether they are 'a net asset or liability.' Although the Delaware River Basin is one of the smallest in the country, it provides water to help serve about 30 million people. In addition, there are more citizen organizations working for water conservation in this basin than in any other in the country. The watershed movement started with the Brandywine Valley Association in the 1940's and has included 18 watershed associations covering about 12 per cent of the Delaware River Basin. Two illustrations are given of single-purpose watershed associations and a third is described as having laid the ground work for a multi-purpose comprehensive plan for county development. The Delaware River Basin Commission is described as having hired a watershed planner with the stated objective of helping to develop other grass roots, resource-oriented, citizens groups throughout the basin. However, of the 18 associations that have existed in the Basin only seven are really active. The author, executive director of the Water Resources Association of the Delaware River Basin describes his group and lists the keys necessary to maintain an effective working group—real problems, concerned citizenry, dynamic leadership, and cooperative agencies. It is urged that when citizens do not like a program they

research acceptable new ones that will be better. The type of action to be discouraged is illustrated by four cases where the sole purpose was to stop water development. (Preckwinkle-Chicago)
W70-06950

ARE WE OR ARE WE NOT GOING TO CLEAN UP,

Metropolitan Sanitary District of Greater Chicago, Ill.

For primary bibliographic entry see Field 05D.
W70-06951

ENVIRONMENTAL GEOLOGY AS AN AID TO URBAN AND INDUSTRIAL GROWTH IN NORTHWEST ALABAMA,

Alabama State Geological Survey, Tuscaloosa.

Paul H. Moser.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 392-398.

Descriptors: *Urbanization, *Planning, *Engineering geology, *Hydrologic data, *Engineering structures, *Geologic mapping, Groundwater, Surface waters, Water quality.

Identifiers: *Environmental geology, *Expansion corridors, Muscle Shoals.

With population increases in this country, urban and industrial expansion is anticipated as being quite dramatic. The role of environmental geology in contributing to the necessary planning is discussed with attention directed toward expansion corridors in northwest Alabama. The results of the investigations are envisioned as furnishing planners with a comprehensive, detailed, practical study, which can be used to stimulate and then maintain an orderly urban and industrial growth. Lauderdale, Colbert, and Franklin counties were the site of the first environmental investigation, a brief outline of which is included. Information concerns hydrology, associated resources, geology and engineering geology. Quantities of potential surface and groundwater are mentioned, and discussion is given to the quality (expressed in amounts of dissolved solids). The urban nucleus, the Muscle Shoals area, is briefly described in terms of population concentration. Three roughly drawn areas are seen from a geological and physiographical viewpoint, and detailed geologic maps are indicated as being available and extremely valuable in planning. In the Muscle Shoals area, it is concluded, 80 per cent of the slopes are gentle enough to present no difficulties for any type of planning. Finally, the importance of engineering capacity is discussed. The bearing capacity of the soil is mentioned because it determines types and sizes of footings necessary for various kinds of construction. Mentioned also in this regard is consideration of flood plains, drainage, soil classifications, mapping of sink holes, and soil thickness. (Preckwinkle-Chicago)
W70-06952

PUBLIC INVESTMENT PLANNING IN THE UNITED STATES: ANALYSIS AND CRITIQUE,

Harvard Univ., Cambridge, Mass.

Arthur Maass.

Water Spectrum, Vol. 2, No. 1, p. 1-8, Spring, 1970. 8 p.

Descriptors: *Project planning, *Multiple-purpose projects, *Benefit-cost-analysis, Federal government.

Two important techniques, multiple-purpose planning and benefit-cost analysis, for evaluating public investments in natural resources have been used since the New Deal period. The goal of multi-objective planning has not been realized, in part because of limitations that have been imposed on the use of benefit-cost analysis. The second goal, multipurpose planning, has been overdeveloped, in part because the techniques used for this end have

been used to compensate for the retarded development of benefit-cost analysis. The reasons for this uneven accomplishment are explored, both those reasons owing to the evolution of the analytical techniques themselves and those that are related to bureaucratic conduct and to executive-legislative relations. (Grossman-Rutgers)
W70-06957

CRITERIA FOR FEDERAL EVALUATION OF RESOURCE INVESTMENT,

Cornell Univ., Ithaca, N.Y. Water Resources and Marine Sciences Center.

Robert J. Kalter, William B. Lord, David J. Allee, and Emery N. Castle.
August 1969. 9 p, 12 ref.

Descriptors: *Evaluation, *Economic efficiency, *Cost-benefit analysis, Federal government, Investment.

Identifiers: Flood Control Act 1936.

The Flood Control Act of 1936 has been generally interpreted to imply that economic analysis of federal water resources investment be carried out under the criterion of national economic efficiency through benefit-cost analysis methods. National efficiency analysis requires that project affects to be estimated in an effort to determine if the present value of the expected benefit stream exceeds the present value of the expected cost stream. The setting in which decision criteria are to function is examined. Then the criteria problem is discussed, with emphasis on recognizing the appropriateness of economic objectives other than efficiency. Finally, further recommendations are offered which would improve the evaluation of public investments in water and related natural resources. (Grossman-Rutgers)
W70-06959

WATER RESOURCES OF IOWA.

Iowa State Geological Survey, Iowa City.

Horick, Paul J., editor. Proceedings of Symposium held at Iowa Academy of Science at the University of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, Jan 1970. 175 p.

Descriptors: *Water resources, *Iowa, Precipitation (Atmospheric), Surface waters, Groundwater, Water quality, Water utilization, Floods, Water pollution, Water law, Water management (Applied), Economics, Research and development.
Identifiers: Water resources management.

This monograph contains eleven papers that were presented at a Water Resources Symposium held at the Eighty-First session of the Iowa Academy of Science at the University of Northern Iowa on April 18, 1969. It is a summary of some of the more important segments of the water resource situation in Iowa. The topics discussed include precipitation, surface water resources, groundwater resources, water quality, water use, floods, pollution, water law, water resources management, economic considerations in water planning, and the importance of water resources research. (See also W70-06982 thru W70-06988). (Knapp-USGS)
W70-06981

MANAGEMENT OF IOWA'S WATER RESOURCES,

Office of Water Resources Research, Washington, D.C.

H. Garland Hershey.

In: Water Resources of Iowa, Symposium Proceedings, Iowa Academy of Science at Univ of Northern Iowa, Cedar Falls, April 18, 1969. Published by University Printing Service, Iowa City, p 123-140, Jan 1970. 18 p, 2 fig, 1 tab, 5 ref.

Descriptors: *Water management (Applied), *Water law, *Water resources development, *Iowa, Legislation, Groundwater, Surface waters, Conjunctive use, Injection wells, Water rights.

Identifiers: Water resources management (Iowa).

Iowa has one of the most comprehensive mechanisms in the United States for the overall management of surface- and groundwater resources. The facilities for managing water are largely at hand through laws, policies and procedures now operable; and in Iowa, unlike most other states, they apply to both surface and groundwaters. Flood-plain zoning is permissible in Iowa and acceptance of it is growing. Disposal of wastes underground is prohibited and at present it is the policy of the state to discourage any waters to be diverted underground. Priority of use has not been set in Iowa except that private-domestic and a few other uses are not regulated. In areas where large water users concentrate in restricted areas, protected low flows are established for streams on a formula basis. There is a growing tendency to look to the principle of conjunctive use. (See also W70-06981). (Knapp-USGS)
W70-06988

THE GRAND CANYON CONTROVERSY: LESSONS FOR FEDERAL COST-BENEFIT PRACTICES,

RAND Corporation, Santa Monica, Calif.
Alan Carlin.

Land Economics, Vol 44, No 2, p 219-227, May 1968. 12 ref.

Descriptors: *Water resources development, *Cost-benefit analysis, *Project planning, *Economic justification, *Colorado River Basin, Colorado River, Cost-benefit ratio, Economics, Interest rate, Discount rate, Feasibility, Feasibility studies, Costs, Benefits, Economic feasibility, Project feasibility, Project benefits, Dams, Reservoirs, River basin development, Alternative costs, Governments, Water resources, Transmission (Electrical).

Identifiers: *Grand Canyon (Ariz), *Water resources projects, *Bureau of Reclamation, *Colorado River Basin Project, *Central Arizona Project.

The proposal to build two dams in the Grand Canyon as part of the Colorado River Basin Project precipitated a controversy between economists and conservationists on the one hand and government agencies (especially the Bureau of Reclamation) on the other. Among the questionable cost-benefit practices used by the Bureau to justify building the dams were: (1) choice of the 'most likely' alternative rather than the least cost alternative; (2) use of higher interest rates and taxes in evaluating alternatives to the projects; (3) use of unreasonable assumptions with regard to the transmission costs of alternatives; (4) use of interest rates below current costs of borrowing by the federal government when computing proposed project costs. All of these practices are at variance with accepted economic principles and raise the important question of whether federal water agencies can objectively evaluate projects they will later be asked to build. Political realities point to the mutual interests of members of Congress anxious to obtain federal projects for their areas and federal water agencies looking for business. Although a new set of economic guidelines is necessary, so is an impartial group to apply them to proposed water projects. (Carr-Arizona)
W70-07054

INSTITUTIONAL CONSTRAINTS AND ECONOMIC OPTIMA - A BASIS FOR MANAGEMENT DECISIONS IN INTRAREGIONAL WATER TRANSFER,

California Univ., Berkeley.

C. Dirck Ditwiler.
Land Economics, Vol 44, No 2, p 173-184, May 1968. 16 ref.

Descriptors: *Water transfer, *Decision making, *Economics, *Institutional constraints, *Political constraints, California, Water resources, Water policy, Administration, Water allocation (Policy), Governments, Institutions, Groundwater, Over-

draft, Water supply, Economic efficiency, Welfare economics, Legal aspects, Analysis, Model studies, Salinity, Semiarid climates, Optimum development plans.

Identifiers: *Economic optimum, Salinas Valley (Calif), Water economy.

The groundwater overdraft problems of the Salinas Valley of California are used as the focal point of an analysis of optimal water management rationale for intraregional water transfer. Traditional economic solutions and their modern counterparts are considered. The analysis suggests that, in contrast to what would be possible in an unconstrained context of economic optimality, the political-institutional-economic structure of the local water economy has prevented almost all movement toward an economic efficiency solution. Changes in institutional structures and forces are likely to be very slow. Therefore, an attempt is being made to create a quantitative model which would recognize these variables and constraints in developing specific operating rules for water management in the valley. (Carr-Arizona)
W70-07055

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOLUME II, APPENDIX.

Federal Water Pollution Control Administration, Washington, D.C.

For primary bibliographic entry see Field 06B.

W70-06839

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOLUME III, (SEWERAGE CHARGES).

Federal Water Pollution Control Administration, Washington, D.C.

For primary bibliographic entry see Field 06B.

W70-06840

THE COST OF CLEAN WATER AND ITS ECONOMIC IMPACT, VOL. IV. PROJECTED WASTE WATER TREATMENT COSTS IN THE ORGANIC CHEMICALS INDUSTRY.

Rice (Cyrus Wm.) and Co., Pittsburgh, Pa.

For primary bibliographic entry see Field 06B.

W70-06841

ESTIMATING CONSTRUCTION COSTS OF WASTE WATER TREATMENT SYSTEMS,

Auburn Univ., Ala. School of Engineering.

For primary bibliographic entry see Field 05D.

W70-06842

CHAPTER 10: SOME ISSUES IN PRESENT PRACTICES OF PROJECT EVALUATION.

Washington Univ., St. Louis, Mo.

For primary bibliographic entry see Field 06B.

W70-06860

COST OF CONVENTIONAL AND ADVANCED TREATMENT OF WASTE WATER,

Robert A. Taft Water Research Center, Cincinnati, Ohio. Advanced Waste Treatment Research Lab.

For primary bibliographic entry see Field 05D.

W70-06869

THE ECONOMICS OF WATER QUALITY,

Rutgers - The State Univ., New Brunswick, N.J.

Water Resources Research Inst.

For primary bibliographic entry see Field 05G.

W70-06937

ECONOMICS OF IRRIGATION SYSTEM CONSOLIDATION,

Colorado State Univ., Fort Collins. Dept. of Economics.

For primary bibliographic entry see Field 03F.
W70-06956

6D. Water Demand

WATER USE IN TENNESSEE: PART C - MUNICIPAL WATER USE,

Geological Survey, Nashville, Tenn.; and Tennessee Dept. of Conservation, Nashville. Div. of Water Resources.

Alfred M. F. Johnson, and John M. Wilson.
Tennessee Department of Conservation, Division of Water Resources Report, 1970. 22 p, 1 fig, 11 tab, 9 ref.

Descriptors: *Water utilization, *Municipal water, *Tennessee, Water users, Water demand, Data collections, Surveys, Water management (Applied), Water requirements.
Identifiers: Municipal water use (Tenn).

To implement the water-use registration law, which was passed by the 1963 Tennessee General Assembly, the State Division of Water Resources undertook a water-use survey in 1964. A questionnaire was distributed to all known municipalities with community-wide distribution systems. Three-fourths of the population of the State are furnished water by a municipal or community-wide distribution system. In 1964 over 400 systems provided 2,750,000 people with a daily supply of 105 gallons of water per person. Average daily water-use ranged from about 75 gallons per person for small communities, to almost 115 gallons per person in the metropolitan areas. During the 4-year period, 1961-64, there was a net increase of about 10% in the number of water distribution systems. The rate of increase will depend on the availability of an adequate supply of potable water, economics, and the urbanization pattern. (Knapp-USGS)
W70-06735

URBAN AND INDUSTRIAL WATER SUPPLY: PROSPECTS AND POSSIBILITIES,

North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.

Jabbar K. Sherwani.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec 1-3, 1965, Urbana, Illinois, 1966, p 189-207, 17 ref.

Descriptors: *Water supply, *Water demand, *Future planning (Projected), Water utilization, Water users, Urbanization, Economic life, Public health, Human population, Technology, Methodology, Standards, Regulation, Legal aspects, Groundwater, Surface waters, Water reuse, Waste water treatment, Demineralization.

Identifiers: *Institutional changes, Agricultural demand, Industrial demand, Municipal demand, Regional governments.

The article is divided into three sections: (1) water demand; (2) water supply; and (3) institutional considerations. Section 1 discusses the present level and composition of water use; the future direction of water supply development, as determined by social and cultural changes, stimulation of economic growth and healthfulness of environment; the consequences of urban expansion, which signify that water supply and waste disposal should determine, rather than follow, urban physical forms; economic growth; health aspects; probable changes in water use patterns, based on population growth, economic activity and technological change; agricultural, municipal and industrial demands; future changes in regulations and standards; and the research necessary to predict future water demand. Section 2 discusses possible sources of supply. Most water will come from conventional sources: surface and ground. Major developments will be: shifts from existing uses, mostly agricultural; reuse of waste waters; technological advances in water and waste treatment; demineralization; and adjustment of water quality to use. Section 3 predicts a complete regionalization of water

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Group 6D—Water Demand

supply systems, with corresponding governmental, legal and policy changes. The interrelationship between water supply and other planning activities is discussed. (Gossen-Chicago)
W70-06935

RECREATION IN WATER RESOURCES DEVELOPMENT, Resources for the Future, Inc., Washington, D.C.

Jack L. Knetsch.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec 1-3, 1965, Urbana, Illinois, 1966, p 182-188, 9 ref.

Descriptors: *Recreation demand, *Decision making, Methodology, Evaluation, *Recreation facilities, *Project planning, Forecasting, Economics, Demand, Supply.

Identifiers: *John Kerr project.

Current interest in recreation is a demand but not a need. It focuses on two issues relating to the use of water resources for recreation: (1) economic evaluation of recreation services produced by water projects and the implications for project planning; and (2) projection of demand and use of outdoor recreation facilities. The recommended method for calculating recreation benefits is based on an imputed demand curve for recreation facilities, using travel cost data as a proxy for price. The method is illustrated with the case of an existing reservoir—the John Kerr project of the Corps of Engineers located in Virginia-North Carolina. The dangers are discussed of putting recreation on an equal selection basis with traditional alternatives. Past statements of demand have not been true projections of demand, but projections of consumption. The data they have been based on are attendance figures. The figures in themselves do not separate demand and supply and therefore have limits to their conceptual or statistical value. Another important and under-considered factor is the possibility of substitution between different kinds of activities or facilities to meet recreation demand. (Gossen-Chicago)

W70-06936

WATER REQUIREMENTS OF WATER-FOWL MARSHLANDS IN NORTHERN UTAH,

Utah Water Research Lab., Logan; and Utah State Univ., Logan. Cooperative Wildlife Research Unit.

J. E. Christiansen, and J. B. Low.

Utah Division of Fish and Game Publication No 69-12, 1970. 108 p, 24 fig, 31 tab, 52 ref.

Descriptors: *Consumptive use, *Wetlands, *Water quality, *Water requirements, *Utah, Aquatic habitats, Fish, Aquatic life, Waterfowl, Aquatic plants, Evapotranspiration, Evaporation, Transpiration, Data collections, Hydrologic data, Water management (Applied), Water conservation.

Identifiers: Waterfowl marshes.

The use of water by the marshlands of northern Utah, as indicated by calculation of evapotranspiration from inflow-outflow data, varies from about 4 in. in April to 9 in. in June, decreasing to 3 in. in October for a 7-month total of about 41 in. These determinations were correlated with climatic data to determine the monthly coefficient K according to the Blaney-Criddle formula, which was used to estimate consumptive use. Values of K for the Blaney-Criddle formula varied from 0.90 for April to 1.20 for June, decreasing to 0.60 for October. Water varied in quality from excellent to poor. Relationships were developed for estimating monthly water requirements based on considerations of evapotranspiration, quality of water, and precipitation. Recommendations are made on quality and quantity of water, drainage, desirable water levels, and desirable plants for efficient marshland operation. (Knapp-USGS)

W70-06995

HIGHEST AND BEST USE: AN ECONOMIC GOAL FOR WATER LAW, For primary bibliographic entry see Field 06E. W70-07067

HIGHEST AND BEST USE: AN ECONOMIC GOAL FOR WATER LAW (REASONABLE USE VERSUS BENEFICIAL USE AND THE CONCEPT OF 'HIGHEST AND BEST USE'), For primary bibliographic entry see Field 06E. W70-07069

6E. Water Law and Institutions

ZIMMERMAN V UNION PAVING CO. (ACTION TO RETAIN WATER RIGHTS).

134 Pa Super 372, 4 A 2d 319-324 (1939).

Descriptors: *Pennsylvania, *Easements, *Excavation, *Water rights, Right-of-way, Springs, Judicial decisions, Legal aspects, Spring waters, Seepage, Prescriptive rights, Damages, Relative rights, Competing uses, Gravitational water, Obstruction to flow, Alteration of flow.

In his deed plaintiff was granted a right to conduct water from a designated spring on grantor's land through a pipe to plaintiff's premises and a right to obtain his water from another unnamed spring. Plaintiff laid pipe from both springs and conveyed water to his premises for over 8 years. Defendant, a road paving company, acquired from plaintiff's grantor the right to excavate soil from the grantor's land. The excavation site was at the base of a hill on which the unnamed spring was located. Defendant's superintendent was notified of the seepage of water from and the possible damage to the unnamed spring from excavation. As a result of the continued excavation, the water flow through plaintiff's pipe was halted, and plaintiff had to transport the water from the unnamed spring by hand. Plaintiff's action for trespass to recover for the interference with and destruction of his property right in the unnamed spring resulted in a favorable judgment at the trial court. The Pennsylvania Superior Court, in affirming, held that where the deed giving plaintiff the right to water from the spring on grantor's remaining land was uncertain as to the identity of the spring and the manner of use, but water was piped by the plaintiff for over eight years without objection, defendant could not claim that the piping of water was unauthorized. (Powell-Florida)

W70-06759

STATE EX REL STATE HIGHWAY COMM'N V ESELMAN (CONDEMNATION OF PROPERTY FORMED BY ACCRETION).

179 SW2d 749-752 (Mo Ct App 1944).

Descriptors: *Missouri, *Condemnation, *Boundaries (Property), *Accretion (Legal aspects), Land tenure, Eminent domain, Legal aspects, Levees, Farms, Land use, Drainage, Culverts, Ditches, Boundary disputes, Damages, Judicial decisions, Riparian land, Right-of-way, Condemnation value, Road construction, Rivers, Highways.

During proceedings to condemn land for road construction, the defendant condemnees claimed damage to land formed by accretion. The plaintiff condemned argued that defendants did not own the property. In order for the owner of a tract of land to have the right to land formed by accretion, argued the plaintiff, the river itself, not metes and bounds or other descriptions, must be made the boundary. The plaintiff claimed that as no evidence had been adduced to show that the river was the boundary of the defendants' property, the defendants could neither show ownership of the accreted land nor claim damages for it. The court conceded the correctness of the argument as to the necessity for the river boundary, but pointed out that no question had been raised at trial as to ownership of the pro-

perty in question. Further, defendants cultivated the tract as part of their farm and all parties had considered it as part of defendants' farm. Under these facts, defendants were declared to be the owners of the land, formed by the accretion. (Caldwell-Florida)

W70-06822

KENTUCKY RIVER COAL CORP V MAYNARD (BOUNDARY DISPUTE: AVULSION OR ACCRETION).

120 SW2d 401-404 (Ky 1938).

Descriptors: *Kentucky, *Boundary disputes, *Avulsion, *Accretion (Legal aspects), Alteration of flow, Streams, Boundaries (Property), Bank erosion, Land tenure, Surveys, Meanders, Ditches, Dams, Obstruction to flow, Railroads, Legal aspects, Judicial decisions, Roadbanks, Riparian rights, Streamflow, Channels.

Defendant claimed ownership of a small tract of land lying on plaintiff's side of a stream which was the common boundary for some distance between plaintiff's and defendant's property. Defendant's contention was that the construction of a railroad some years before, running parallel with the creek, had changed the course of the stream by avulsion. Plaintiff sought to enjoin the defendant from digging a ditch along the old channel and constructing a dam in order to reroute the creek along the ditch. The court held that the defendant had the burden of proving that the creek had changed course by avulsion and that as he had failed to sustain this burden, a change by accretion would be presumed. The plaintiff was held to have title to the land formed by accretion. Defendant sought to establish that his deed laid out the boundary by courses and distances and included the disputed tract. Other language in the deed, however, called for the boundary to run with the meanderings of the stream, and the court held that in case of such a conflict, the meanders of the stream prevailed. Plaintiff was thus held entitled to an injunction. (Caldwell-Florida)

W70-06836

CONNECTICUT'S ADMINISTRATIVE CONTROL OF WATER POLLUTION -- THE FLUID ADMINISTRATIVE PROCESS,

Connecticut Univ., Inst. of Water Resources.

For primary bibliographic entry see Field 05G.

W70-06844

WATER LAW IN THE UNITED STATES,

Wyoming Univ., Laramie. Coll. of Law.

Frank J. Trelease.

Proceedings of the First Annual Meeting of the American Water Resources Association at the University of Chicago, Dec 1-3, 1965, Urbana, Illinois, 1966, p 47-54.

Descriptors: *Water law, *History, Water resources development, *Prior appropriation, *Riparian rights, Water permits, Federal jurisdiction, State jurisdiction, Recreation, Planning, Water supply.

Identifiers: Groundwater law, Institutional law, Water quality laws, Federal Water Pollution Control Act, Inflexible laws.

An overview is provided of present water laws and compares them with those of the past, emphasizing that the law is beneficial rather than restrictive and that it can be changed as the will of the majority changes. Section I shows how the law encourages development. The law of prior appropriation spurred water resources development in a pioneer economy. Present appropriation laws require the granting of a permit to appropriate water. Using this power, western water officials have chosen from competing projects the ones which promised the greatest benefits. Evolution of the riparian rights laws, groundwater law, institutional law, and federal development has followed the same pattern of advancing the good of the people. Section II con-

siders water quality laws at the state and federal levels. It traces the development of legal control from the days of private suits for private nuisances to the passage of the Federal Water Pollution Control Act. Section III marks trends concerning recreation use, water supply planning, and inflexible laws and plans. It is predicted that water law in the future will continue to undergo revision according to the will of the majority. (Gossen-Chicago) W70-06930

CRITERIA FOR FEDERAL EVALUATION OF RESOURCE INVESTMENT,
Cornell Univ., Ithaca, N.Y. Water Resources and Marine Sciences Center.
For primary bibliographic entry see Field 06B.
W70-06959

AGRICULTURAL DEVELOPMENT IN NORTHERN MEXICO, 1940-1960,
Stanford Univ., Calif.
For primary bibliographic entry see Field 03F.
W70-07052

INSTITUTIONAL CONSTRAINTS AND ECONOMIC OPTIMA - A BASIS FOR MANAGEMENT DECISIONS IN INTRAREGIONAL WATER TRANSFER,
California Univ., Berkeley.
For primary bibliographic entry see Field 06B.
W70-07055

COLD FACTS ON HOT WATER: LEGAL ASPECTS OF THERMAL POLLUTION,
For primary bibliographic entry see Field 05G.
W70-07059

TECHNOLOGY, OCEAN MANAGEMENT, AND THE LAW OF THE SEA: SOME CURRENT HISTORY,
Edward Miles.
Denver Law Journal, Vol 46, No 2, p 240-260,
Spring 1969. 21 p, 74 ref.

Descriptors: *Oceans, *International waters, *Jurisdiction, *Resource development, Technology, Legal aspects, International law, International commissions, United Nations, Mineralogy, Mining, Oil, Drilling, Fishing, Fisheries, Weather, Climates, Economics, Political aspects, Continental shelf, Navigation, Treaties, Oceanography, Exploration, Exploitation, Military aspects, Management, Ownership of beds, Beds under water.
Identifiers: *Ocean floor, *Territorial sea.

The law of the sea is beset with many problems regarding claims of national jurisdiction over the ocean floor contiguous to nation-states. The two areas of controversy are conflicting claims of territorial sea and the extent of jurisdiction over the ocean floor for exploration and exploitation of resources. Advancing marine technology has made the second area more important because of its impact both on economics and national security. Since 1930 there have been several international conferences dealing with the extent of the territorial sea. Unanimity of policy has never been achieved but there has been a trend towards more nations claiming limits greater than the traditional three mile limit. The problem over jurisdiction of the continental shelf derives from the ambiguous wording of the 1958 Geneva Convention on the Continental Shelf. A nation can claim jurisdiction over the ocean floor beyond water depths of 200 meters if it is able to exploit the resources of these areas. With recent technological innovations in drilling, mining, fishing, and weather prediction such exploitation is now possible. The effect of these innovations has been to extend coastal states' jurisdiction beyond the traditional limits. The need for some sort of definitive agreement among nations is evident. A workable international system should be established which would insure the national security of participating nations. (Duss-Florida)

W70-07060

THE OUTER LIMIT OF THE CONTINENTAL SHELF,

Luke W. Finlay.

American Journal of International Law, Vol 64, No 1, p 42-61, Jan 1970. 20 p, 69 ref.

Descriptors: *Continental shelf, *International commissions, *International law, *Continental slope, Standards, Continental margin, Oceans, International waters, Law of the sea, Federal government, Legal aspects, Exploration, Exploitation, Oil industry, Political constraints, Political aspects, Judicial decisions, Beds under water, Ownership of beds, Institutional constraints, Governments, United Nations, Foreign countries, Conferences.

The Geneva Convention on the Continental Shelf of 1958 laid down the standard that coastal nations have sovereign rights over continental shelves to a depth of 200 meters, the approximate limit of most continental shelves, or to such depth beyond 200 meters as is reasonably exploitable. A split of authority has arisen over whether this standard should be interpreted to include all the geographical continental shelf, even beyond the 100 meter standard. The author supports the interpretation that all the shelf should be exploitable, opposing the view that an arbitrary standard of a given number of miles from shore should prevail. The author argues that both the shelf and the continental slope were intended to be controlled by the coastal nation. An earlier inter-American conference adopted provisions supporting this thesis. Such provisions were approved and implicitly adopted by the Geneva Conference. The author contends that a limit in terms of miles from shore would be arbitrary and that extending the limit to a greater depth would result in excessive amounts of ocean beds being claimed by coastal nations. Defining the limits of the continental shelf as its geographical area, including the continental slope, is reasonable and more susceptible of international agreement and support. (Caldwell-Florida)
W70-07061

JURISDICTION OF THE FEDERAL POWER COMMISSION OVER NON-POWER WATER USES,

William R. Walker, and William E. Cox.

Land and Water Law Review, Vol 5, No 1, p 65-75, 1970. 11 p, 29 ref.

Descriptors: *Federal Power Act, *Hydroelectric project licensing, *Federal project policy, *Multiple-purpose projects, Federal government, Legislation, Hydroelectric plants, Water resources development, Project purposes, Powerplants, Structures, Flood control, Water utilization, Dams, Reservoirs, Reservoir management, Non-consumptive use, Recreation, Water allocation (Policy), Multiple-purpose reservoirs, Usable storage, Permits, Beneficial use, Navigable waters.

New legislation and the Federal Water Power Act (FWPA) seem to provide the authority for the Federal Power Commission to play a larger role in the storage of water for non-power used in the future. The FWPA shifted the responsibility for licensing non-federal water resource projects from Congress to the Federal Power Commission. The FPC was directed to think in terms of comprehensive development plans. It was also authorized to act, after a license is issued, to alter and impose additional requirements on the licensee. It cannot act unilaterally, but it can impose open-end conditions at the time of issuance. In 1968 the FWPA was amended to allow non-power uses to be incorporated into new licensing agreements. In addition to issuing licenses for power projects in navigable waters or on public lands, the FPC may issue licenses for utilizing surplus water from any government dam for any beneficial public use, including non-power purposes. The legislative history of the Act indicates that the drafters contemplated this authority. Also, a prior act that dealt with non-power projects was repealed, and its provisions

were integrated into the FWPA. (Doublerley-Florida)
W70-07062

OHIO SURFACE WATER RIGHTS,

S. M. Nechemias.

University of Cincinnati Law Review, Vol 38, No 3, p 525-538, Summer 1969. 14 p, 82 ref.

Descriptors: *Ohio, *Reasonable use, *Surface water, *Contours, Repulsion (Legal aspects), Riddance (Legal aspects), Legal aspects, Banks, Watercourses (Legal), Land use, Flow, Channels, Drainage systems, Canals, Ditches, Surface drainage, Civil law, Easements, Streams, Ponds, Relative rights.
Identifiers: *Servitudes.

The purpose of this note is to indicate how Ohio landowners can legally use their land with respect to contour changes altering the flow of surface water. The note emphasizes the various rules pertaining to water rights of upper and lower landowners. American jurisdictions have tended to adopt either the common enemy rule, the civil law rule, or the reasonable use rule. Ohio surface water law began with the adoption of the Civil Law Rule. The capacity-of-the-stream rule and the urban rule have also been significant in the history of Ohio surface water law. The author advocates the adoption of the reasonable use rule to allow for the fairest results with the greatest flexibility. Numerous judicial decisions are discussed. 'Surface water' and 'watercourse' are defined. (See also W70-07064 thru W70-07066) (Leesfield-Florida)
W70-07063

OHIO SURFACE WATER RIGHT (COMMON ENEMY, CIVIL LAW, AND REASONABLE USE RULES),

S. M. Nechemias.

University of Cincinnati Law Review, Vol 38, No 3, p 525-528, Summer 1969. 4 p, 21 ref.

Descriptors: *Repulsion (Legal aspects), *Reasonable use, *Civil law, *Surface runoff, Surface waters, Land tenure, Drainage water, Jurisdiction, Easements, Riddance (Legal aspects), Land use, Natural flow, Legal aspects, Drainage systems, Relative rights, Contours, Judicial decisions.
Identifiers: *Servitudes.

Surface water rights in the United States have been determined by one of three rules. The common enemy rule allows the possessor of land an unlimited right of use in such land regardless of harm which he may cause to others due to a change in surface water flow. However, most courts do not allow the land possessor an unlimited privilege to rid his land of surface water. The civil law rule states that a person who interferes with the natural flow of surface water, thereby disturbing another's enjoyment of his land, is liable for damages. Thus, the upper owner's land is said to enjoy an easement for the natural flow of water over the lower owner's land. This rule permits no interference with the natural flow. When strictly applied, this rule greatly restricts the improvement of urban land. The reasonable use rule establishes no specific rights or privileges. It provides that each possessor may make reasonable use of his land, and allows for the alteration of the surface water flow. Reasonableness is a question of fact in each case. (See also W70-07063) (Leesfield-Florida)
W70-07064

OHIO SURFACE WATER RIGHTS (CIVIL LAW RULE, CAPACITY OF STREAM RULE, URBAN RULE),

S. M. Nechemias.

University of Cincinnati Law Review, Vol 38, No 3, p 528-536, Summer 1969. 8 p, 51 ref.

Descriptors: *Ohio, *Civil law, *Surface runoff, *Riddance (Legal aspects), Surface waters, Land tenure, Legal aspects, Ditches, Ponds, Overflow,

Field 06—WATER RESOURCES PLANNING

Group 6E—Water Law and Institutions

Natural flow, Streams, Watercourses (Legal), Drainage systems, Farm management, Airports, Flooding, Banks, Land development, Repulsion (Legal aspects), Urbanization, Judicial decisions, Relative rights, Easements, Land use. Identifiers: *Servitudes, Urban rule.

Ohio surface water law began with the adoption of the civil law rule. A series of cases established a trend toward the view that the lower land is subject to a servitude in favor of the upper land and must receive water which naturally flows onto the lower land. Exceptions to this rule allowed an increase in the flow of water in natural drainways and watercourses. The capacity of the stream rule is also applied by Ohio courts. The rule provides that an upper riparian owner can increase and accelerate the stream flow only to the extent its natural banks can carry it. Ohio's urban rule is in effect a modified common enemy rule. This rule was necessitated by the fact that Ohio courts do not consistently apply the civil law rule to urban land. Determining whether land is urban or rural in Ohio is a mechanical process. Land within the corporate limits of a municipality is urban; otherwise it is rural. The reason for this rule is to encourage land improvement without the necessity of using natural water drainage. Ohio's urban rule has been limited by case law. It never applies to upper owners and only occasionally to lower owners. (See also W70-07063) (Leesfield-Florida)
W70-07065

OHIO SURFACE WATER RIGHTS (ADOPTION OF REASONABLE USE RULE), S. M. Nechemias.

University of Cincinnati Law Review, Vol 38, No 3, p 536-538, Summer 1969. 3 p, 30 ref.

Descriptors: *Ohio, *Reasonable use, *Civil law, *Repulsion (Legal aspects), Land use, Streams, Surface waters, Ditches, Natural flow, Drains, Legal aspects, Riddance (Legal aspects), Diversion, Drainage systems, Surface runoff, Land tenure, Urbanization, Contours, Judicial decisions, Relative rights, Land development, Watercourses (Legal).

Ohio is now forced to apply two sets of rules. When dealing with rural lands the civil law rule is justifiable. However, the common enemy rule is appropriate as a general principle of urban law because city land requires severe alterations to the surface. The existence of separate rules leads to confusion. The problems of Ohio surface water law can best be solved by the adoption of the reasonable use rule. The philosophy supporting this rule simply states it is incumbent on every person to take reasonable care, in using his property, to avoid injury to others. However, a person threatened with injury must also take reasonable precautions to avoid or reduce potential injury. This rule gives maximum flexibility without resort to artificial exceptions. The rule is explicit enough to avoid confusion. Reasonableness should be based on the amount of harm caused, foreseeability of harm, and all other relevant facts. The court should also consider the ability of the injured party to mitigate damages. (See also W70-07063) (Leesfield-Florida)
W70-07066

HIGHEST AND BEST USE: AN ECONOMIC GOAL FOR WATER LAW,

Donald R. Levi.
Missouri Law Review, Vol 34, No 2, p 165-177, Spring 1969. 13 p, 33 ref.

Descriptors: *Missouri, *Prior appropriation, *Reasonable use, *Water conservation, Conservation, Legal aspects, Judicial decisions, Competing uses, Riparian rights, Water allocation (Policy), Water policy, Water rights, Preferences (Water rights), Equitable apportionment, Regulation, Relative rights, Beneficial use, Economics, Marginal costs, Real costs, Cost-benefit analysis, Economic justification, Water demand, Social aspects, Legislation.

The concept of highest and best use is explored as a basis for the allocation of the increasingly scarce water supplies. The concept of highest and best use calls for the use which will yield the greatest positive net profit. This is analogous to the most beneficial use concept in economic theory in that it envisions a marginal allocation among users. Rather than viewing one use as being categorically higher valued than another, the best use concept requires that each unit of water be allocated to the use wherein the incremental value of the product produced is a maximum. The reasons for the lack of maximal use of water are examined. Legislative mechanisms are suggested to achieve the highest and best use of currently existing water supplies. Suggestions for an economically sound system of water rights are presented as a step toward bringing the highest and best use of water into reality. (See also W70-07068 thru W70-07070) (Barnett-Florida)
W70-07067

HIGHEST AND BEST USE: AN ECONOMIC GOAL FOR WATER LAW (INTRODUCTION), Donald R. Levi.

Missouri Law Review, Vol 34, No 2, p 165-168, Spring 1969. 4 p, 14 ref.

Descriptors: *Missouri, *Reasonable use, *Beneficial use, *Conservation, Prior appropriation, Legal aspects, Judicial decisions, Competing uses, Riparian rights, Water allocation (Policy), Water policy, Water rights, Preferences (Water rights), Equitable apportionment, Regulation, Relative rights, Economics, Governments, Cost-benefit ratio, Cost-benefit analysis.

Regulating the right to use water is an economic problem when there is a water scarcity. Pollution and population increases affect the scarcity of usable supplies. Consequently, some form of governmental regulation is required. A system is needed which will optimally allocate water among competing users. Many social scientists believe the economic principle of highest and best use is the pivotal doctrine around which a system of water law ideally should be built. The theory is that society should receive the greatest possible benefit from the existing water supply. Legal scholars talk in terms of reasonable use and beneficial use. An economist defines beneficial use as one in which the value of the benefits received from usage is greater than the cost of utilization. The legal definition of beneficial use varies with cases and statutes. For example, in New Mexico beneficial use has been defined as the use of such water as may be necessary for some useful and beneficial purpose in connection with the land from which it is taken. This definition is not functional. The exact determination of beneficial use is a fact question in each case. (See also W70-07067) (Barnett-Florida)
W70-07068

HIGHEST AND BEST USE: AN ECONOMIC GOAL FOR WATER LAW (REASONABLE USE VERSUS BENEFICIAL USE AND THE CONCEPT OF 'HIGHEST AND BEST USE'), Donald R. Levi.

Missouri Law Review, Vol 34, No 2, p 168-172, Spring 1969. 5 p, 18 ref.

Descriptors: *Conservation, *Missouri, *Reasonable use, *Beneficial use, Prior appropriation, Preferences (Water rights), Illinois, Louisiana, Legal aspects, Judicial decisions, Competing uses, Riparian rights, Water allocation (Policy), Water policy, Water rights, Equitable apportionment, Regulation, Relative rights, Economics, Cost-benefit ratio, Costs, Mathematical studies, Project planning, Marginal costs, Real costs, Cost-benefit analysis, Economic justification, Natural resources, Resource allocation, Water demand.

Reasonable use and beneficial use are synonymous, but each is usually associated with a different system of water law. The question of reasonableness does not arise until there are competing users of a given source. Comparing the reasonableness of

two competing uses necessitates a determination of the use with the higher value. Economists use the term highest and best use as a synonym for most beneficial use, i.e., the use giving the greater positive addition to social product, while yielding the maximum social benefit. Courts have seldom given the term highest and best use any meaning. Courts in both Illinois and Louisiana have construed the term and implicitly recognized that maximizing the extent by which marginal value product exceeds marginal factor costs is the appropriate goal and that total costs and gross returns are not the relevant criteria for water-use management decisions. The definition of most beneficial use that is acceptable to both economists and legal technicians is a combination of the legal construction of most as in the highest degree plus the economist's definition of beneficial use, which is when marginal value product exceeds marginal factor cost. (See also W70-07067) (Barnett-Florida)
W70-07069

HIGHEST AND BEST USE: AN ECONOMIC GOAL FOR WATER LAW (LEGISLATIVE MECHANISMS FOR ACHIEVING HIGHEST AND BEST USE), Donald R. Levi.

Missouri Law Review, Vol 34, No 2, p 173-177, Spring 1969. 5 p.

Descriptors: *Missouri, *Legislation, *Economics, *Reasonable use, Prior appropriation, Conservation, Beneficial use, Permits, Preferences (Water rights), Legal aspects, Competing uses, Riparian rights, Water allocation (Policy), Water policy, Water rights, Equitable apportionment, Regulation, Relative rights, Project planning, Public health, Natural resources, Resource allocation, Water demand, Social aspects.

Statutory schemes can be employed to achieve or approximate the highest and best use concept of water allocation. The reasonable use doctrine lacks certainty in that it requires litigation to determine whether the riparian owner has in fact made a reasonable use. It does not provide the certainty of rights that will precipitate cash outlays to install diversion facilities for water use, which would minimize the potential use of water. Certainly could be added in three ways: (1) giving landowners the right to use a definitive quantity of water; (2) making a division by percentages among those presently holding usage rights in a given source, and (3) adopting a prior appropriation doctrine, with the order of diversion establishing the order of rights to water use. It is submitted that making a water right freely transferable separate from the land is important to encourage beneficial water utilization. Permit systems are also suggested, as well as an administratively enforced transfer system. Another suggestion, termed the legislative determination of highest and best use, is an ordered list of preferences among general usage classifications. Other legal mechanisms are also suggested. (See also W70-07067) (Barnett-Florida)
W70-07070

CONTEMPORARY DEVELOPMENTS IN WATER LAW.

Contemporary Developments in Water Law, Water Resources Symposium, C. W. Johnson and S. H. Lewis (editors), Vol 4, p 1-172, 1970. 172 p.

Descriptors: *Water conservation, *Water resources development, *Water law, *Water management (Applied), Water quality, Water rights, Water quality control, Water utilization, Regulation, Non-structural alternatives, Riparian rights, Administrative agencies, Federal government, Legal aspects, Legislation, Natural resources, Water allocation (Policy), Water supply, Environment engineering, Federal project policy, Multiple-purpose projects, Flood control, Competing uses, Water distribution (Applied).

Adaptation of the law of water rights to changing social conditions is discussed with both a narrow and a broad focus. Legal assurances of water quality, the relationships between water quality and water rights, and governmental efforts to achieve regional water quality management and control are examined. A model water use act for a riparian state, Florida, is reviewed. Municipal preference statutes, particularly the Texas Wagstaff Act, are analyzed. The regulation of groundwater in humid zones is discussed. Governmental flood control measures, the encroachment of land uses such as filling and building upon scenic and recreational waterways, and the crucial role of law in the planning of water resources development, including the extent to which the private citizen and the courts should have a voice in the planning process are other subjects dealt with. (See also W70-07096 thru W70-07105). (Powell-Florida) W70-07095

A MODEL WATER USE ACT FOR A RIPARIAN STATE—THE FLORIDA EXPERIENCE, F. E. Maloney.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 1-26, 1970. 26 p, 118 ref.

Descriptors: *Florida, *Administration, *Legislation, *Water law, Legal aspects, Interstate compacts, Prior appropriation, Riparian rights, Water permits, Water rights, Adjudication procedure, Administrative agencies, Competing uses, Regulation, Water allocation (Policy), Watershed management, Water management (Applied), Water supply, Water works, Aquifers, Dams, Water pollution, Beneficial use, Priorities, Reasonable use, Surplus water, Saline water intrusion, Hydrologic cycle, Surface groundwater relationships, Impoundments, State governments.

The need for legislation to regulate emerging water resource problem is imperative for our society today. In 1957, Florida enacted the Water Resources Law. The Law was drafted mainly with concern for the two major consumptive use problems in Florida: waste and unreasonable use. Because of weaknesses in the act regarding permit regulation of the use of excess water beyond riparian land, the Florida Model Water Use Act has been proposed. The constitutional problems of regulation of property for the general welfare are examined. Having explained the proposed Model Act's general approach and administrative structure, the provisions for water management districts, consumptive use permits, surface water works and pollution prevention controls are outlined in depth. It is concluded that the necessity of this regulation is to maximize the beneficial use of Florida's water resources in the best interests of all its citizens. (See also W70-07095). (Barnett-Florida) W70-07096

MUNICIPAL WATER PREFERENCE STATUTES: THE TEXAS WAGSTAFF ACT, R. W. Swenson.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 27-39, 1970. 13 p, 51 ref.

Descriptors: *Texas, *Appropriation, *Water allocation (Policy), *Preferences (Water rights), Legislation, Legal aspects, Competing uses, Beneficial use, Priorities, Water rights, Prior appropriation, Distribution, Domestic water, Equitable apportionment, Industrial water, Recreation, Water control, Water policy, Water resources development, Water utilization, Water conservation, Water demand, Water law, Water distribution (Applied), Water management (Applied).

Municipal water preference statutes give the municipality a right to appropriate water that the city finds reasonably necessary, irrespective of the claims of water users who are prior in time, without paying compensation to them for the loss of their rights in the water. The Texas statute recites that

preference and priority be given, in this order, to the following uses: (1) domestic and municipal; (2) manufacturing; (3) irrigation; (4) mining; (5) hydroelectric power; (6) navigation; and (7) recreation and pleasure. Observations in regards to the recapture powers of municipalities under the Texas statute are presented. For example, cities, in recapturing water, are probably limited to those uses which were recognized in 1931 as proper domestic or municipal uses. The legislative wisdom of the statute is explored. The statute differs from other such statutes by requiring no affirmative act on the part of the city with respect to its claims for future water. Another troublesome provision of the Texas statute is the 1931 cut-off date for the protection of vested appropriation rights. A third problem arises concerning the construction of the municipal preference statute in relation to an act governing interbasin transfers in Texas. The constitutionality of the statute, particularly the recapture provision, is discussed. The Wagstaff Act represents an extreme policy of resource allocation that appears inconsistent with state policy in other areas. (See also W70-07095). (Powell-Florida) W70-07097

NEW WATER LAWS FOR OLD AND NEW COUNTRIES, F. J. Trelease.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 40-54, 1970. 15 p, 72 ref.

Descriptors: *Foreign countries, *Prior appropriation, *Appropriation, *Water law, Water rights, Recreation, Natural resources, Legislation, Legal aspects, Geographical regions, Regions, Governments, Foreign waters, Research and development, Long-term planning.

Identifiers: *Comparative law.

All around the world water law seems to be in a state of flux. In recent years a number of countries have revised their laws or enacted water codes to fill a vacuum in their law. A study of these laws discloses that several of them bear a resemblance to western American prior appropriation, incorporating many of its features. The needs behind these newer laws differ from country to country. This comparative study of the extent to which laws arising from such different origins resemble each other emphasizes: (1) England; (2) America; (3) Chile; (4) Israel; and (5) various African nations. It is concluded that western American prior appropriation may offer the most capacity for adaptation and growth in developing nations. Its mechanism of state control over the initiation of development is evolving into an instrument for state planning and the protection of recreation and natural environment. It is flexible enough to deal with the different problems of groundwater and the different conditions of humid areas. Many of its features seem to have universal appeal and application. (See also W70-07095). (Marsee-Florida) W70-07098

REGULATING GROUNDWATER IN HUMID ZONES, For primary bibliographic entry see Field 04B.

W70-07099

RELATIONSHIPS BETWEEN WATER QUALITY AND WATER RIGHTS, For primary bibliographic entry see Field 05G.

W70-07100

REGIONAL WATER QUALITY MANAGEMENT AND CONTROL, Corwin W. Johnson.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 83-95, 1970. 13 p, 34 ref.

Descriptors: *Water quality control, *Regions, *Planning, *Management, Administration, Water

pollution control, Water pollution treatment, Economics, Legislation, State governments, Multi-purpose projects, Water resources development, River basin development, Delaware River Basin Commission, Administrative agencies, Local governments, Treatment facilities, Interstate commissions, River basins, Control systems.

A comprehensive, regional approach to water resources development planning, in terms of entire river basins or major portions thereof, is necessary for effective water quality control. Local solutions are often ineffective because of inadequate treatment facilities and lack of control of the entire problem area. The many variables inherent in any water management effort necessitate the creation of regional water quality control authorities with broad powers to plan for and effectuate an integrated system of water quality management. The trend may be toward making the region the standard basis for both regulation of water quality and disposition of wastes. At present the Delaware River Basin Commission is the only interstate agency qualified to implement a comprehensive regional quality control system. There is no state river basin agency engaged in a truly comprehensive quality management program, although river authorities in Texas and regional authorities in California are beginning to play a more active role in this area. Whether interstate or intrastate, such regional authorities need rule-making and enforcement powers to deal with the water quality problem, especially in metropolitan regions. (See also W70-07095). (Caldwell-Florida) W70-07101

FLOOD PLAIN MANAGEMENT,

Earl B. Schurtz.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 96-111, 1970. 16 p, 99 ref.

Descriptors: *Flood control, *Flood plains, *Land management, Flood plain insurance, Flood plain zoning, River basin development, Watershed management, Federal government, Planning, Programs, Risks, Water injury, Flood damage, Flood protection, Economic impact, Riparian rights, Land use, Legal aspects, Legislation.

Floods continue to be a significant national problem and flood damage increases each year. Several new methods have been proposed to deal with the problem. Flood plain insurance encourages local governments to prevent unwise use of flood plains, reducing the exposure of property to floods and makes available coverage otherwise non-existent. Executive agencies have been ordered to initiate flood control and prevention measures. State and local governments are passing new legislation regulating flood plain occupancy and use. At common law, courts could act only to prevent or provide redress for acts causing flood damage to others. Flood waters were not dealt with as diffused surface waters but as part of the overflowing stream. The central issue in cases arising from flood plain legislation is the extent of the government's police power. Local governments have generally been accorded wide discretion by the courts in regulating uses of land in flood plains. Zoning, building codes, and establishment of encroachment lines have all been upheld. Restrictions upon land use, however, must be reasonable and not arbitrary. (See also W70-07102). (Caldwell-Florida) W70-07102

NEW SMALL LAKE LAW--OPEN SPACE AND RECREATION VERSUS FILLING AND BUILDING,

R. W. Johnson, and G. R. Morry.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 112-135, 1970. 24 p, 69 ref.

Descriptors: *Cities, *Landfill, *Buildings, *Lakes, Urbanization, Legal aspects, Zoning, Condemna-

Field 06—WATER RESOURCES PLANNING

Group 6E—Water Law and Institutions

tion, Washington, Riparian rights, Navigable waters, Nonnavigable waters, Ownership of beds, Easements, Scenic easements, Reasonable use, City planning, Community development, Land use, Urban sociology, Social aspects, Judicial decisions, Legislation, Public rights, Lake shores.

Identifiers: *Urban lakes.

The lack of adequate open spaces in the metropolitan areas of the nation is tragic. Even in those communities where small lakes provide such space, a steady encroachment of fills and buildings pushes further into the water. Law has been slow to develop for the control of this phenomenon. This paper deals with this small problem primarily in those jurisdictions which have recognized a riparian right of common use over the entire surface of the lake. Various methods which might be used to control fill and building on lake beds include the following: (1) the reasonableness test as stated in the riparian rights doctrine; (2) the riparian-right versus no-riparian-right test applied by the Washington Supreme Court in *Bach v Sarich*, 445 P2d 648 (1968); (3) zoning; (4) public ownership of lake beds; (5) public ownership of scenic easements over the surface of the water; (6) private agreements among riparian owners; and (7) condemnation. Advantages and disadvantages of each method are considered. Also discussed is the control of fill and building on navigable waters. The article concludes that a combination of the various control methods is necessary. (See also W70-07103). (Marsee-Florida)

W70-07103

A REVIEW OF THE TEXAS WATER PLAN: ISSUES AND ATTITUDES,

Comer Clay.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 160-172, 1970. 13 p, 49 ref.

Descriptors: *Texas, *Political aspects, *Water resources development, *Water supply, Administration, Administrative agencies, Costs, Financial feasibility, Financing, Water quality control, Water demand, Reclamation states, Southwest U.S., Political constraints, Surveys, Desalination plants, Multiple-purpose projects, Water conveyance, Water costs, Water delivery, Water requirements, Water shortage.

The state of Texas is presently faced with a water crisis that it is attempting to solve with an ambitious and far-reaching scheme to provide water for Texas for the next fifty years—the Texas Water Plan. The future of water in Texas depends greatly upon the political success of this plan. A recognition of the importance of this political factor has precipitated this study. Over 455 officials and citizens of Texas and New Mexico have been surveyed for their opinions and attitudes toward the Plan. Five major issues related to the Plan are discussed: (1) the need for additional water in Texas; (2) the need for water quality as well as water quantity protections; (3) possible sources from which to obtain additional water; (4) the form and organization of an administrative body to implement the water program; (5) costs and methods of financing the Plan. (See also W70-07095). (Marsee-Florida)

W70-07104

PUBLIC RIGHTS IN PUBLIC RESOURCES: THE CITIZEN'S ROLE IN CONSERVATION AND DEVELOPMENT,

J. L. Sax.

Contemporary Developments in Water Law, Water Resources Symposium, Vol 4, p 136-159, 1970. 24 p, 90 ref.

Descriptors: *Public rights, *Federal government, *Administrative agencies, *Natural resources, Conservation, Adjudication procedure, Judicial decisions, Legislation, Water law, Administration, Jurisdiction, Federal jurisdiction, Regulation, Water resources development, Legal aspects, Environment.

That the public has legally enforceable rights in natural resources is hardly a novel proposition. What is novel is the growing tendency for such rights to be asserted not by governmental agencies on behalf of the people, but by citizen groups, frequently against the very governmental agencies which are supposed to protect the public interest. This article concentrates upon the assertion of these rights at the federal level only: claims against federal agencies and the opportunity for litigation in the federal courts. Ironically, case law relating to citizen's rights in public resources has evolved not out of governmental indifference to environmental quality, but out of an abundance of legislative enactments creating such rights. Where environmental mandates to administrative agencies are ignored, may the citizen enforce that mandate as against the agency. Numerous judicial decisions are discussed as examples in this area. Consideration is given to: (1) issues of the citizen's standing to sue; (2) whether a general statutory mandate creates a public right; (3) governmental agencies' immunity to suit; (4) review of administrative decisions; and (5) the amount in controversy as a bar to federal court access. (See also W70-07095). (Marsee-Florida)

W70-07105

LEWALLEN V MAYS (BOUNDARY DISPUTES BETWEEN OPPOSITE RIPARIAN OWNERS).

95 SW2d 1125-1129 (Ky 1936).

Descriptors: *Kentucky, *Boundaries (Property), *Boundary disputes, *Streams, Surveys, Land tenure, Land use, Bench marks, Bank erosion, Legal aspects, Judicial decisions, Riparian land, Farms, Structures, Real property, Water law.

A dispute arose as to whether the words in plaintiff's and defendant's deeds should be interpreted to call for a straight line boundary, or one running with the meanders of a creek. The court said that in any case of possible conflict, language calling for a specific, straight line boundary of known distance and direction must prevail over general language indicating the creek as boundary. The court held that the straight line boundary conformed to the original patent from the sovereign and was the correct one. The court further found that the plaintiff, who had argued for the straight line boundary, had adversely possessed the land in dispute for many years, treating the straight line as the true boundary of the property. (Caldwell-Florida)

W70-07107

HORTON V SHACKLETT (EASEMENT TO A SPRING).

95 SW2d 939-938 (Tenn Ct App 1936).

Descriptors: *Tennessee, *Easements, *Springs, *Water supply, Access routes, Water utilization, Remedies, Damages, Spring waters, Water holes, Consumptive use, Potable water, Prescriptive rights, Water rights, Water consumption, Legal aspects, Water sources, Groundwater basins, Livestock, Judicial decisions.

Defendants fenced in a spring from which plaintiffs had been accustomed to drawing water. The defendants conceded plaintiffs' easement in the spring, but claimed that they had constructed a basin outside the fence and that this was the one plaintiffs must use. The plaintiffs claimed also that their original easement included the right to drive livestock over defendants' land. The court held that the plaintiffs were entitled to use the waters in the original spring basin, and ordered defendants to construct gates in the fence. However, it was also held that plaintiffs' easement did not include the right to drive livestock over defendants' land to the spring. The court reasoned that such an easement should be limited to uses reasonably necessary and convenient and should avoid burdens on the servient estate. (Caldwell-Florida)

W70-07108

KIRK V KENNEDY (SOVEREIGN IMMUNITY PLEA BY STATE AGENCY IN QUIET TITLE ACTION).

231 So 2d 246-249 (2d D C A Fla 1970).

Descriptors: *Florida, *Accretion (Legal aspects), *Beaches, *Boundary disputes, Land tenure, Legal aspects, Judicial decisions, State governments, Administrative agencies, Beach erosion, Boundaries (Property), Jurisdiction, Shores.

Several landowners brought suit against the trustees of the State Internal Improvement Fund to quiet title to beach property which had accreted in front of and appurtenant to the landowners' property. Although originally alleging title to the property in themselves, the trustees filed a motion to dismiss the suit on the grounds of sovereign immunity. The landowners argued that the participation by the trustees in the action, affirmatively alleging title in themselves, acted as a waiver of sovereign immunity. The court held that immunity had not been waived by the trustees, as the earlier pleading had been completely withdrawn at the time of the motion to dismiss presently under consideration. The concurring opinion emphasized the scope of the problem of title to accreted beach property due to the nature of Florida's coastline, and urged legislation authorizing quiet title suits against the trustees. (Caldwell-Florida)

W70-07111

WOOD V WILLIAMS (CONTRACT RIGHTS TO THE USE OF WATER LINES).

184 SW2d 799-801 (Ky 1945).

Descriptors: *Kentucky, *Easements, *Prescriptive right, *Water contracts, Boundaries (Property), Contracts, Judicial decisions, Legal aspects, Local governments, Preferences (Water rights), Proprietary power, Relative rights, Water rights, Pipes, Piping systems (Mechanical), Remedies.

Plaintiff and defendant owned adjoining property purchased from a common owner. The prior owner's residence was on plaintiff's property, and the prior owner had constructed a private water line through defendant's property from the residence to the main water line. Defendant purchased his tract and connected his residence with the private line. Later plaintiff purchased his tract, and in seeking to obtain water service for his residence found that the city would not service both residences through the same line. The city agreed to provide such service only if all the water so used would be paid for by defendant. All parties signed a contract to that effect, which contract also stated that either the city or defendant could require plaintiff to install his own lines if they so desired. Plaintiff sued to enjoin defendant from exercising that option on the ground that he had an easement by prescription over defendant's property. The court held that plaintiff waived whatever prescriptive right he had when he entered into the contract with defendant, since at that time plaintiff's use of the water line became permissive. (Clarke-Florida)

W70-07114

CITY OF HARRODSBURG V CUNNINGHAM (ABANDONMENT OF PRESCRIPTIVE EASEMENTS).

184 SW2d 357-361 (Ky 1945).

Descriptors: *Kentucky, *Easements, *Prescriptive rights, *Dams, Judicial decisions, Legal aspects, Land tenure, Land use, Real property, Boundaries (Property), Proprietary power, Relative rights, Reservoirs, Riparian rights, Water rights, Backwater, Water supply, Flooding, Flood damage, Floodwater.

Identifiers: *Abandonment.

Plaintiff city purchased land for the purpose of damming a stream and creating a water supply reservoir. There already existed across the stream a dam which the owner's grantor had built to operate

a grist mill. The dam had caused water to back up 1.5 miles and had flooded the land belonging to defendant's grantor for such a length of time that a prescriptive right to such flooding arose and was not contested. Some 18 years before the litigation, however, the owner of the dam, plaintiff's vendor, had partially removed it, allowing the stream to flow freely. He admitted at trial that he had had no intention of rebuilding the dam. Plaintiff sued for a declaration of the rights of the parties. The court found the law to be well settled that an easement may be lost by abandonment. In the case of an easement by grant, nonuse alone is never enough to constitute abandonment. In addition thereto, there must be some act by an adverse party, acquiesced in by the owner of an easement, or attendant facts which indicate an intention on the part of the owner to abandon it. Where the easement is prescriptive, however, long, continued nonuse of it raises the presumption of abandonment. Here the nonuse of the prescriptive easement for 18 years, coupled with the owner's act of removing the dam, clearly indicated an intention to abandon the easement. (Clarke-Florida)
W70-07115

CLARK V TILTON (RIGHT TO USE WATER FROM PRIVATE WATER MAIN).

148 SW2d 649-651 (Ark 1944).

Descriptors: *Arkansas, *Water supply, *Water contracts, *Water users, Conduits, Relative rights, Water utilization, Water consumption, Measurement, Conveyance structures, Closed conduits, Water conveyance, Legal aspects, Water rights, Judicial decisions, Reasonable use, Water works, Water permits, Water sources, Hydrants, Pipes.

Several persons joined together to construct a private water line. Defendants purchased a portion of the property which had belonged to one of the original owners and made a new connection onto the line. Plaintiffs, other owners of the line, sought to force severance of the connection. The court conceded that private landowners could construct a private waterline and prevent others from taking water from it. However, the court found no evidence of any intent to restrict use of the line only to the original owners and held that defendants had acquired the right from their grantor to connect onto the line. As the water used by defendants had been charged to another owner's meter, the case was remanded for a determination of the amount owed by defendants to that owner. The court also ordered a meter installed on defendants' connection. (Caldwell-Florida)
W70-07117

INGRAM V GREAT LAKES PIPE LINE CO (DESTRUCTION OF SPRING BY BLASTING)

153 SW2d 547-555 (Mo Ct App 1941).

Descriptors: *Missouri, *Damages, *Springs, *Excavation, Easements, Contracts, Jurisdiction, Legal aspects, Overlying proprietor, Water rights, Confined water, Groundwater, Water supply, Water demand, Fouling, Fractures (Geology), Cracking, Pipelines, Ditches, Rock mechanics, Right-of-way, Judicial decisions.

Identifiers: *Blasting.

Plaintiff executed to defendant pipe line company, for the purpose of laying pipe lines, an easement over her farm land. A natural spring, which provided water for plaintiff's livestock, was located not far from defendant's right-of-way. Despite plaintiff's warnings about the spring, defendant employed dynamite to excavate a layer of thick rock encountered in the right-of-way. After the blasting, the spring disappeared. Plaintiff sued for the difference in the value of the land and for the loss of the spring. Defendant argued that plaintiff had not conclusively proved that the blasting caused the spring to dry up, that it was impossible for the blasting to have such an effect and that, in fact, a severe drought caused the drying up of the spring. The

court held that, considering the expert testimony and other evidence on both sides, the jury was warranted in finding that the stream dried as a result of the blasting. The court further held, however, that as a matter of law, plaintiff was not entitled to damages both for the depreciated value of her property and the loss of the spring. Damages for depreciated property value was the correct measure. (Clarke-Florida)
W70-07118

STEPHAN V KENTUCKY VALLEY DISTILLING CO (RIGHT TO USE SPRING WATERS).

122 SW2d 493-498 (Ky 1938).

Descriptors: *Kentucky, *Springs, *Spring waters, *Usufructuary right, Water utilization, Land tenure, Competing uses, Access routes, Easements, Legal aspects, Water rights, Relative rights, Water supply, Legislation, Judicial decisions, Water allocation (Policy), Water sources, Water demand.

A common vendor of plaintiff and defendant sold the plaintiff a portion of the vendor's tract on which was located two springs. The vendor expressly retained the right to use the spring waters. Through mesne conveyances, defendant gained title to the portion originally retained by the common vendor, and claimed the vendor's right to use the spring waters. The court held that the terms of plaintiff's deed were sufficient to vest the right to use the spring waters in the vendor and that this right was properly conveyed to defendant. Plaintiff claimed that the common vendor and defendant's predecessors in title had abandoned the right through non-use. The court rejected this claim. The court found that plaintiff was estopped from seeking to prevent defendant's use of the water as he had stood by and watched defendant construct an expensive distilling plant in reliance upon the use of the springs. Although the plaintiff's deed only referred to 'the spring', this was construed to refer to both springs as a single source of spring waters. (Caldwell-Florida)
W70-07121

KELLY V CITY OF CAPE GIRADEAU (REMEDIES FOR CITY'S FAILURE TO COMPLY WITH INJUNCTION TO ABATE NUISANCE).

89 SW2d 693-698 (Mo Ct App 1936).

Descriptors: *Missouri, *Abatement, *Flooding, *Remedies, Cities, Flood damage, Judicial decisions, Legal aspects, Drainage, Drains, Outlets.

Identifiers: Injunctions, Nuisances.

In 1919 plaintiff obtained an injunction ordering the defendant city to abate the nuisance of flood waters which regularly collected on plaintiff's property. Upon failure of defendant to provide satisfactory drainage facilities for the property, plaintiff over the years instituted a series of damage suits against the city. In the present case, plaintiff sought to force the city officials to comply with the order. The court held that as the present officials were still bound by the original decree, the action necessarily was one for contempt. The original decree had not been devitalized by the state 10 year statute of limitation for execution of judgments, as the statute only applied to money judgments. The original decree was held insufficient to sustain and action for contempt, and plaintiff's appeal was dismissed. (Caldwell-Florida)
W70-07124

RUGGLES V DANDISON (DISPUTED RIPARIAN RIGHTS TO THE USE OF A LAKE).

279 NW 851-853 (Mich 1938).

Descriptors: *Michigan, *Boundary disputes, *Riparian land, *Prescriptive rights, Boundaries (Property), Judicial decisions, Land tenure, Legal

aspects, Riparian rights, Riparian waters, Usufructuary right, Water rights, Banks, Water utilization, Lakes, High water mark, Low water mark, Overflow, Wetlands, Remedies, Barriers, Water levels, Water level fluctuations.

Plaintiff and defendant owned adjoining land. A lake on defendant's land was located fairly close to the boundary between such land and plaintiff's land. In periods of unusually high water, water from the lake would cross onto plaintiff's land. Otherwise plaintiff's land closest to the lake was merely boggy. Defendant built a fence along the boundary which prevented plaintiff's access to the lake. Plaintiff sued to enjoin the maintenance of the fence on the grounds that he was a riparian owner or, in the alternative, that he had a prescriptive right to the use of the lake. The court held that riparian ownership was a question of fact, and the evidence here indicated that the natural condition of the lake was not such that it adjoined plaintiff's property. The court further held that plaintiff's use of the lake had always been at the sufferance of defendant and not open, notorious and hostile for the statutory period of time required to give rise to a prescriptive right. (Clarke-Florida)
W70-07126

LAKELANDS INC V CHIPPEWA AND FLAMBEAU IMPROVEMENT CO (BOUNDARY DISPUTES CAUSED BY ERROR IN ORIGINAL GOVERNMENT SURVEY OF LAKE FRONT PROPERTY).

295 NW 919-926 (Wis 1941).

Descriptors: *Wisconsin, *Boundary disputes, *Surveys, *Lakes, Land tenure, Mapping, Jurisdiction, Meanders, Boundaries (Property), Shores, Legal aspects, Judicial decisions, Costs, Measurement, Administrative agencies, Federal government, Relative rights, Allotments, Riparian land, Water levels.

Plaintiff, the defendant's grantee, found one lg in possession of part of the lake-shore property which was the subject of a land sale to plaintiff. lg appealed to the federal government for a resurvey of the area, claiming that the surveyed meander line of the lake boundary did not reflect the true line of the lakeshore. A resurvey was undertaken and the disputed property awarded to lg by the federal government, whereupon plaintiff sued defendant, his grantor, for breach of warranty of title. The court held that the federal government had no right to reallocate ownership of parcels of land by resurveying the area, since the original error was not large enough to constitute a fraud on the government. The meander line shown on the plat of the area was held not to indicate boundaries, but to indicate the approximate acreage of the respective lots. The true boundaries of the lots, the court held, were to be determined by running the original boundary lines down to the point where they intersected the lakes actual boundary. The warranties in defendant's deed to plaintiff were thus not breached because the federal government's action contravening plaintiff's title was invalid. (Caldwell-Florida)
W70-07127

SWARTZ V SHERSTON (RIPARIAN RIGHTS: LAKE FRONTOAGE).

300 NW 148-151 (Mich 1941).

Descriptors: *Michigan, *Boundaries (Property), *Prescriptive rights, *Riparian rights, Ownership of beds, Boundary disputes, Easements, Judicial decisions, Legal aspects, Proprietary power, Relative rights, Riparian land, Riparian waters, Beds, Lake beds, Water rights, Watercourses (Legal), Lakes, Recreation facilities, Piers.

Plaintiff and defendant were adjoining landowners whose properties abutted a large inland lake. The section line dividing the properties ran through a small portion of the north end of the lake giving defendant very little lake frontage. Both parties

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rented boats to the public and operated beach facilities. From time to time plaintiff allowed defendant to anchor a diving dock and slide on the water over his submerged land. Disputes between the parties as to the use of the lake caused plaintiff to commence construction of a fence along the section line across the lake. Defendant sued to enjoin such construction, which would prevent his boats from using the lake. Plaintiff cross-billed, seeking to enjoin defendant from anchoring his dock and slide over plaintiff's submerged land. Defendant claimed a prescriptive right thereto by adverse possession. In the first instance, the court found the law to be well settled that several riparian owners to an inland lake may use the surface of the whole lake for boating and fishing, so far as not to interfere with the reasonable use of the waters by other riparian owners. Secondly, the court held that permissive use by defendant of plaintiff's submerged lands for anchorage could not ripen into a prescriptive right since hostility is the very essence of adverse possession. (Clarke-Florida)

W70-07128

WEST BOUNTIFUL, AND WOODS CROSS, UTAH.

Corps of Engineers, Sacramento, Calif.
For primary bibliographic entry see Field 04A.
W70-06789

REGIONAL PLANNING AND FLOOD PLAIN MANAGEMENT,

Pennsylvania State Planning Board, Harrisburg, Pa.
Irving Hand.

Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 241-254.

Descriptors: *Flood control, *River basin commissions, *Administrative agencies, *Coordination, *Non-structural alternatives, Interstate compacts.

Identifiers: *Regional planning, *Flood plain management, Basin development plans, *Public information, *Federal-interstate compacts.

W70-06946

alternatives and combinations, and finally the implementation phase. The major objective of wise flood plain management is defined as overall local, regional, and national welfare. With this objective, the necessity for evaluating various concepts such as environmental values or needs for areal economic development and for evaluating alternative engineering and managerial techniques is indicated. Because of increasing complexities involving Federal, State or local governments, attention is given to understanding the responsibilities and relationships of each. Finally, several examples are given of the 'blending' of structures with the economic and social needs at respective sites, again illustrating Local-State-Federal relations. (Preckwinkle-Chicago)

6F. Nonstructural Alternatives

FLOOD PLAIN INFORMATION, BOULDER CREEK AND SOUTH BOULDER CREEK: VOLUME II - BOULDER METROPOLITAN REGION, COLORADO.

Corps of Engineers, Omaha, Nebr.
For primary bibliographic entry see Field 04A.
W70-06767

FLOOD PLAIN INFORMATION, TUALATIN RIVER AND TRIBUTARIES, WASHINGTON COUNTY, OREGON.

Corps of Engineers, Portland, Oreg.
For primary bibliographic entry see Field 04A.
W70-06773

FLOOD PLAIN INFORMATION ON MAIN STEM AND SOUTH BRANCH BIG TIMBER CREEK IN CAMDEN AND GLOUCESTER COUNTIES, NEW JERSEY.

Corps of Engineers, Philadelphia, Pa.
For primary bibliographic entry see Field 04A.
W70-06777

FLOOD PLAIN INFORMATION, CHRISTINA RIVER, EAST AND WEST BRANCHES, NEWARK, NEW CASTLE COUNTY, DELAWARE.

Corps of Engineers, Philadelphia, Pa.
For primary bibliographic entry see Field 04A.
W70-06781

FLOOD PLAIN INFORMATION OF UMATILLA RIVER IN MISSION - RIVERSIDE AREA NEAR PENDLETON, OREGON.

Corps of Engineers, Walla Walla, Wash.
For primary bibliographic entry see Field 04A.
W70-06785

FLOOD PLAIN INFORMATION, SOUTH FORK EEL RIVER, PHILLIPSVILLE TO GARBerville, HUMBOLDT COUNTY, CALIFORNIA.

Corps of Engineers, San Francisco, Calif.
For primary bibliographic entry see Field 04A.
W70-06786

FLOOD PLAIN INFORMATION, CALLEGUAS CREEK, VENTURA COUNTY, CALIFORNIA.

Corps of Engineers, Los Angeles, Calif.
For primary bibliographic entry see Field 04A.
W70-06787

FLOOD PLAIN INFORMATION, BARTON, MILL, AND STONE CREEKS, BOUNTIFUL,

The need for regional planning for flood control and flood plain management is reviewed, and an outline of groups and agencies involved in this planning is made. Discussed briefly are the responsibilities of river basin agencies, Federal agencies such as Corp of Engineers and the United States Geological Survey, various state water resources planning programs, and multi-county regional planning agencies organized by their component units of county government. Experience is perceived as indicating a trend toward both structural and non-structural measures used in concert with the protection and management of flood plain areas. A growing number of basin study coordinating committees, comprehensive river basin development surveys, Federal-interstate compacts to implement basin plans and statewide water resource plans are also mentioned. Tools available for planning and flood plain management are considered with the regional planning agency given first attention. Advisory roles of the planning agency are stressed, and plans for future development, public information, and coordination are listed as the most important functions. Specific non-structural measures open to local units of government are listed. Included are: zonning in the flood plain, subdivision regulation, building and construction codes and the official map, public information, outright purchase of land, acquisition of development rights, and easements to preserve open space. (Preckwinkle-Chicago)

W70-06945

COMPREHENSIVE FLOOD PLAIN MANAGEMENT REQUIRES BLENDING OF TECHNOLOGY AND SOCIAL FACTORS,

James E. Goddard.
Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 233-240, 24 ref.

Descriptors: Technology, Population, *Local governments, Regions, Federal government, Structures, *Environmental effects, Regulations, Economic efficiency, *Data collection.

Identifiers: *Flood plain management, *Comprehensive planning, Economic development.

Population growth and distribution have created flood problems more rapidly than flood control is correcting them. And, at the same time, flood control structures are sometimes counter to overall interests and needs of an area. What is therefore becoming widely recognized is that comprehensive plans based on broad management concepts for all our natural resources is necessary. The need to clarify the term 'flood plain management' and the need for coordinated comprehensive thinking with consideration of all alternatives are discussed. Outlined are basic steps in achieving flood plain management: basic data for officials or individuals with interest in the problem, studies to determine most acceptable flood plain regulations, comprehensive studies including all kinds of applicable

WISCONSIN'S FLOOD PLAIN AND SHORELAND MANAGEMENT PROGRAM,

Wisconsin Dept. of Natural Resources, Madison.

Thomas G. Frangos, and Thomas M. Lee.
Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 263-275, 3 fig, 11 ref.

Descriptors: *Standards, *State jurisdiction, *Flood plain zoning, *Regulation, Taxes, Topography.

Identifiers: *Flood plain management, *Wisconsin Water Resources Act, *Shoreland management, *Joint state-local action, Public purchase, Sanitary districts.

The need for a flood plain and shoreland management program in Wisconsin is outlined and protection regulations are indicated as potentially serving as an effective resource management tool. The Wisconsin Water Resources Act is discussed. Joint state-local action is aimed for, with state responsibilities, including the establishment of minimum statewide standards for flood plain and shoreland regulations, assistance to communities in the adoption of regulations, and surveillance of the enforcement of the local regulations. Progress toward adoption and implementation of shoreland regulations and management are described. Objectives of the regulations are presented with model ordinances providing for three shoreland land use districts, subdivision regulations, and a sanitary code. Success of implementation is described as impressive overall. In case of delinquency, the state can administer and enforce regulations. The flood plain management program is discussed: Guidance in developing flood plains is the objective, not prohibition. Three parts are identified: evaluation of flooding potential and identification of flood plains; formulation, administration, and enforcement of regulations; and continuous review of flood plain management criteria. Problems of inadequate information or technical help are mentioned in reference to communities faced with flood plain development plans; steps in drafting local regulations with currently available information are suggested. (Preckwinkle-Chicago)

W70-06947

FLOOD PLAIN MANAGEMENT,

For primary bibliographic entry see Field 06E.
W70-07102

6G. Ecologic Impact of Water Development

AN ECOLOGICAL STUDY OF THE TWIN CITIES METROPOLITAN AREA,

Metropolitan Council of the Twin Cities, Minn.

David A. Wallace.

Available from Clearinghouse as PB-185 849, \$3.00 in paper copy, \$0.65 in microfiche. Twin Cities Metropolitan Council Report, June 1969. 127 p, 41 tab, 83 ref, 3 append.

Descriptors: *Ecology, *Cities, *Urbanization, *Land use, *Planning, Water resources development, Water management (Applied), Land development, Land management, Recreation, Parks, Land classification, Land resources.
Identifiers: Minneapolis and St. Paul (Minn.).

An ecological survey was made of the Minneapolis-St. Paul area, Minnesota, to be used in urban planning. Each of the major categories of geology (historical and surficial), physiography, hydrology (ground and surface water), soils, plant ecology, and wildlife habitats (terrestrial and aquatic), are mapped. These major subject areas were searched for attributes of relevance to prospective land uses. Ecological phenomena such as rock types, slopes, rivers, lakes, streams, aquifers, soil types, forest associations, wildlife habitats, and scenic, scientific and historic values, are mapped. These data were related to the major prospective land use groups: Production - including agriculture, forestry, wildlife and extractive minerals; Protection - including unique, scarce or vulnerable resources; Recreation - both active and passive; and two categories of Urbanization residential and industrial-commercial. (Knapp-USGS)
 W70-06764

BIOTIC REGULATION OF PARTICULATE AND SOLUTION LOSSES FROM A FOREST ECOSYSTEM,
 Yale Univ., New Haven, Conn. School of Forestry; and Dartmouth Coll., Hanover, N.H. Dept. of Biological Science.
 For primary bibliographic entry see Field 02J.
 W70-06778

REPORT ON THE BIOLOGICAL FINDINGS OF THE HUDSON RIVER FISHERIES INVESTIGATIONS, 1965-1968,
 Hudson River Technical Committee, Cornwall, N.Y.

Frank T. Carlson, and James A. McCann.
 In: Hudson River Fisheries Investigations, 1965-1968, p 6-50, 1969. 45 p, 12 fig, 24 tab, 40 ref, 11 append.

Descriptors: *Pumped storage, *Hudson River, *Environmental effects, *Fishes, Distribution patterns, Life history studies, Striped bass, Aquatic habitats, Aquatic environment, Aquatic productivity.
Identifiers: Cornwall pumped storage plant (N.Y.).

A pumped-storage, hydroelectric plant is proposed on the Hudson River at Cornwall, N.Y. The distribution of life stages of fish in the Hudson River estuary which are potentially vulnerable to this plant were determined and the impact of possible losses on their populations was studied. The striped bass was given primary emphasis in the study because it is the only species that is the object of a major fishery and is also known to use the estuary near Cornwall as a spawning and nursery area. Substantial numbers of striped bass eggs and larvae would be drawn into the intake of the proposed plant but, of the total production within the estuary, less than 0.7% of the eggs and 2.9% of the larvae would be vulnerable to removable. Up to 6.2% of the young-of-the-year at Cornwall (in the area of influence of the plant) in late summer would be vulnerable to the plant, but this fraction would fluctuate and generally decrease because of increased size of the fish. The operation of the Cornwall plant alone would have negligible effects on the fisheries of striped bass and other species occurring in the estuary. The cumulative effect of operation of additional plants requiring large volumes of water, however, could significantly reduce the production of fish in the river. (Knapp-USGS)
 W70-07024

ENVIRONMENTAL EFFECTS OF IRRIGATION IN THE CENTRAL VALLEY OF ARIZONA,
 Arizona Univ., Tucson. Dept. of Agricultural Engineering; and Arizona Univ., Tucson. Dept. of Agricultural Economics.

Wayne Clyma, and Robert A. Young.
 American Society of Civil Engineers, National Meeting on Environmental Engineering, Chattanooga, Tennessee, May 13-17 1968, Preprint. 28 p, 6 fig, 3 tab, 19 ref.

Descriptors: *Arizona, *Environmental effects, *Irrigation effects, *Water supply, *Water resources development, Irrigation, Irrigation water, Economics, Economic impact, Environment, Deserts, Arid lands, Climate, Vegetation, Groundwater, Groundwater mining, Salinity, Surface water, Water utilization, Water resources, Water transfer, Water quality, Urbanization, Industrial water, Social impact, Social change, Rural areas, Human population, History, Desert Land Act, Land subsidence.
Identifiers: *Irrigated agriculture, Salt River Project, Central Valley (Ariz.).

Irrigation has modified the environment of the Central Valley of Arizona for the past 2500 years, beginning with the irrigation systems of the Hohokam Indians. Modification of the physical environment has included changes in climate, groundwater, surface water and vegetation. The social environment has been changed from a rural economy to an urban industrial economic system. Present and future problems related to irrigation in the area are discussed. Some of the problems are water demand, land subsidence, salinity, groundwater management, and allocation of Colorado River water. Solutions to some of these problems are suggested. (Carr-Arizona)
 W70-07053

07. RESOURCES DATA

7A. Network Design

FLOOD COMPUTATIONS FOR SUBURBS,
 Pennsylvania State Univ., University Park. Dept. of Civil Engineering.

Brian M. Reich.
 Proceedings of the Fourth American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1968), p 276-294, 11 fig, 7 tab, 18 ref.

Descriptors: *Urbanization, *Hydrographs, *Parametric hydrology, *Flooding, *Discharge (Water), *Routing, *Inflow, *Storms, Flood control, Multiple purpose.

Identifiers: *McSparran hydrograph, *Reich hydrograph, *Soil Conservation Service hydrograph, *Johns Hopkins hydrograph.

Although the notion of multiple use of land and water has reached the planning of suburban communities, the necessary flood hydrographs for minimizing cost-benefit ratios have been lacking. Techniques are available for rural watersheds and highly urban areas but not for suburbs. Therefore, three rural methods and one urban procedure were modified for use on three suburban watersheds in southeastern Pennsylvania. These methods were: McSparran's Pennsylvania Synthetic Hydrograph (M); Reich's Small Rural Synthetic Hydrograph (R); Soil Conservation Service's Curvilinear Hydrograph (S); and Johns Hopkins Urban Inflow Hydrograph (J). Discussion of each method and its development is given along with a table listing the hydrograph parameters of each method. The input to all four methods was rainfall with both reservoir and channel routing involved in this problem. Using the three watersheds with 2, 10, and 100 year storms, five measurements were constructed for each method. These included: inflow hydrographs, outflow at lowest point of combined and routed flood, non-reservoir synthetic hydrograph computed at lowest point, rise times, and scour durations. It is concluded that extrapolation of these four hydrograph methods to suburban design in terms of the 'blue and green' requirements give incompatible results. Radically different structural dimensions would result from each alternative hydrograph procedure. Economic analysis would

be correspondingly variable. Finally, the recent stimulus in obtaining hydrologic data for such suburban watersheds should be urgently pursued. (Preckwinkle-Chicago)
 W70-06948

MOIRE PATTERN TECHNIQUES IN GROUND-WATER HYDROLOGY,

Department of Energy, Mines and Resources, Calgary (Alberta). Inland Waters Branch.
 R. Allan Freeze.
 Water Resources Research, Vol 6, No 2, p 634-641, April 1970. 8 p, 4 fig, 19 ref.

Descriptors: *Groundwater movement, *Model studies, *Analytical techniques, Flow nets, Distribution patterns, Potential flow.
Identifiers: Moire patterns.

The moire pattern technique provides a conceptual or teaching tool that can be applied to problems involving the superposition of potential field solutions. Moire interference also forms the basis of a measurement technique that can be adapted for use with the membrane analogy for groundwater flow. (Knapp-USGS)
 W70-07011

7B. Data Acquisition

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR DETECTION OF WATER POLLUTION,
 Georgia Univ., Athens. Dept. of Entomology.
 For primary bibliographic entry see Field 05A.
 W70-06754

AIRBORNE TECHNIQUES IN CLIMATOLOGY: OASIS EFFECTS ABOVE PRAIRIE SURFACE FEATURES,

Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.
 R. M. Holmes.

Inland Waters Branch, Department of Energy, Mines and Resources, Technical Bulletin No 19, Canada, 1969. 28 p, 18 fig, 20 ref.

Descriptors: *Air temperature, *Heat budget, *Evapotranspiration, *Lakes, *Grasslands, Irrigation, Meteorology, Arid lands, Remote sensing, Aircraft, Instrumentation, Surveys, Climatology.
Identifiers: Oasis effect, Alberta (Canada).

A light, single-engine aircraft instrumented to measure air temperature and radiation temperatures of the earth's surface was used successfully to identify several prairie oases. Climatic discontinuities produced by irrigation, agriculture, and prairie lakes were observed. Surface-radiation temperature differences between dry and moist areas were large, and temperature differences of air cooled by passage over these areas were measurable. Under the most extreme conditions measured, air cooling of 3 deg C was noted up to 120 m above Lake Pakowki in southeast Alberta and this cooled air often persisted as far as 10 km downwind from the lee edge of the lake. Surface temperatures of the surrounding land varied greatly and occasionally were 28 deg C warmer than the lake surface. Air temperature profiles obtained near an agriculturally complex area showed the heating and cooling of the atmospheric boundary layer due to surface heating and cooling. Up to 2.0 deg C of heating and 3.0 deg C of cooling of air near the surface was measured as a result of surface characteristics of agricultural and nonagricultural land. (Knapp-USGS)
 W70-06766

AN OSMOTIC METHOD FOR STUDYING THE SUCTION/MOISTURE CONTENT RELATIONSHIPS OF POROUS MATERIALS,
 Rothamsted Experimental Station, Harpenden (England).
 For primary bibliographic entry see Field 02G.

Field 07—RESOURCES DATA

Group 7B—Data Acquisition

W70-06768

ROCKY REACH DAM TURBINE RATINGS BY THE CURRENTMETER METHOD,
Beck (R. W.) Associates.
For primary bibliographic entry see Field 08C.
W70-06776

REAL TIME ROUTING OF FLOOD HYDROGRAPHS IN STORM SEWERS,
Minnesota Univ., Minneapolis. St. Anthony Falls
Hydraulic Lab.
Garth S. Harris.
ASCE Proceedings, Journal of the Hydraulics Division, Vol 96, No HY6, Paper 7327, p 1247-1259, June 1970. 13 p, 12 fig, 6 ref, append. FWQA Demonstration Grant.

Descriptors: *Routing, *Flood routing, *Storm runoff, Floods, Open channel flow, Sewers, Unsteady flow, Hydrographs, Time lag, Computer programs, Flood control, Hydraulics, Waves (Water).
Identifiers: Minneapolis-St. Paul (Minn).

A rapid computation of routed flood hydrographs in circular sewers was required for use in the evaluation of the effect of storm flooding in the Minneapolis-St. Paul Interceptor sewers. The method of characteristics is used to provide the accurate assessment of the routed hydrograph but this method requires a comparatively large amount of computer time. The progressive average-lag method is used to carry out the evaluation in real time. The routing constants in the latter method are determined by comparing the results from the former with those of the latter until good agreement is obtained. It has not been possible to determine the routing constants in the latter method analytically. (Knapp-USGS)
W70-06977

EFFECT OF CONCENTRATION GRADIENTS ON THE PERFORMANCE OF A NUCLEAR SEDIMENT CONCENTRATION GAGE,
Agricultural Research Service, Oxford, Miss. Sedimentation Lab.

J. R. McHenry, N. L. Coleman, J. C. Willis, A. C. Gill, and O. W. Sansom.
Water Resources Research, Vol 6, No 2, p 538-548, April 1970. 11 p, 7 fig, 2 tab, 10 ref.

Descriptors: *Nuclear meters, *Sediment load, *Suspended load, *Gamma rays, Sands, Clays, Radioactivity techniques, Running waters, Sediment discharge.
Identifiers: Nuclear sediment-meter.

A nuclear sediment concentration gage, using the attenuation of 22-kev X rays from cadmium-109 as a function of concentration, was evaluated in a series of laboratory tests conducted in a circulating water tunnel. Sediment concentration measurements were made with the X-ray beam directed up, down, and across the test flume section. Coarse sand, fine sand, and kaolin were used as sediments in concentrations of 100 to 30,000 ppm. The suspensions were passed through the water tunnel at velocities of 0.7 to 3 meters per sec. The response of the nuclear sediment concentration gage was not affected significantly by test position, type or size of particle, or velocity of sediment, but was a function of the total concentration of sediment in the test cross section. (Knapp-USGS)
W70-07001

VELOCITY MEASUREMENT WITH RADIOACTIVE SPHERES,
Illinois Univ., Urbana.
Ben Chie Yen, and Terrence L. McGillivray.
Water Resources Research, Vol 6, No 2, p 609-613, April 1970. 5 p, 2 fig, 11 ref. NSF Grant GY-4212.

Descriptors: *Tracers, *Floats, *Radioactivity techniques, *Tracking techniques, *Current meters, Streamflow, Velocity, Stream gages, Radioisotopes, Instrumentation.

Identifiers: Polystyrene spheres.

The use of radioactive spheres as a flow velocity tracer is feasible. The technique involves trapping a small amount of radioisotope inside sphere and then measuring the motion of the sphere in the flow. For steady uniform subcritical turbulent flows tested with the Reynolds number up to 13,000 and the flow depth to sphere diameter ratio greater than 1.7 the accuracy of flow velocity measurement with floating tracers is usually within 7%. The accuracy can be improved if the correction for the relative velocity between the fluid and the sphere is made. The advantages of this technique are its simplicity, its relatively small contamination problem, its low cost, and its potential to be used in a wide range of flow conditions. (Knapp-USGS)
W70-07015

STOCHASTIC HYDRODYNAMICS OF SEDIMENT TRANSPORT,
Pittsburgh Univ., Pa. Dept. of Civil Engineering.
For primary bibliographic entry see Field 02J.
W70-07023

7C. Evaluation, Processing and Publication

ESTIMATION MONTHLY STREAMFLOWS WITHIN A REGION,
Corps of Engineers, Sacramento, Calif. Hydrologic Engineering Center.
For primary bibliographic entry see Field 04A.
W70-06747

ERROR ANALYSIS OF STREAMFLOW DATA FOR AN ALLUVIAL STREAM,
Geological Survey, Washington, D.C.
D. E. Burkham, and D. R. Dawdy.
Available for sale from Superintendent of Documents, U.S. Government Printing Office, Wash., D.C. 20402 - Price 35 cents. Geological Survey Professional Paper 655-C, p C1-C13, 1970. 13 p, 15 fig, 3 tab, 2 ref.

Descriptors: *Statistical methods, *Stage-discharge relations, *Alluvial channels, *Discharge (Water), Streamflow, Quality control, Hydrologic budget, Discharge coefficients.
Identifiers: Error analysis.

Discharge measurements were used to determine the standard error in computed continuous records of discharge for two streamflow gaging stations on the Gila River. The major source of errors in computed discharge is from poor definition of the stage-discharge relation. The standard errors of computation of discharge for the two stations were determined by randomly choosing a group of discharge measurements for use in rating analysis and using the remaining measurements as a control group. Discharge was computed corresponding to the stage and time of the measurements in the control group. The mean square difference ($m-c$) between measured and computed discharge was determined for different ranges of flow. The mean square difference ($m-c$) is the sum of the mean square difference of the measured discharge from true discharge plus the mean square difference of computed discharge from true discharge. The variance was obtained by subtracting the known variance from the mean square difference ($m-c$). (Knapp-USGS)
W70-06750

SYNTHETIC RAINFALL DATA,
Nevada Univ., Reno. Desert Research Inst.
For primary bibliographic entry see Field 02B.
W70-06758

HYDROLOGIC ENGINEERING TECHNIQUES FOR REGIONAL WATER RESOURCES PLANNING,
Corps of Engineers, Davis, Calif. Hydrologic Engineering Center.

Augustine J. Fredrich, and Edward F. Hawkins.
Hydrologic Engineering Center Technical Paper No 17, U.S. Army Corps of Engineers, Davis, California, 1969. 19 p, 5 plate, 12 ref.

Descriptors: *Computer programs, *Water resources development, *Planning, Systems analysis, Model studies, Synthetic hydrology, Data processing, Hydrology, Optimization, Data collections.
Identifiers: Hydrologic engineering.

Only through the use of electronic computers have hydrologic engineers been able to complete the fundamental hydrologic studies that serve as the foundation for most engineering and economic analyses of complex regional water resources developments. Studies recently completed or in progress include development of a regional flood control site screening plan, use of streamflow simulation for planning and operation of the Missouri River mainstem projects, development of an operation plan for the Arkansas-White-Red Rivers reservoir system, standard project flood estimates, flood frequency estimates, and several other projects. (Knapp-USGS)
W70-06780

HYDROGEOLOGY OF THE BEREA AND CUSSEWAGO SANDSTONES IN NORTHEASTERN OHIO,
Geological Survey, Washington, D.C.
Jon L. Rau.

For sale by U.S. Geological Survey, Wash., D.C. 20402 - Price \$1.00 per set. Geological Survey, Hydrologic Investigations Atlas HA-341, 2 sheets, 1969. Text, 2 fig, 7 map, 3 tab, 14 ref.

Descriptors: *Water resources, *Hydrogeology, *Aquifers, *Ohio, Sandstones, Transmissivity, Specific capacity, Water yield, Permeability, Water quality, Saline water, Brines, Water wells, Water supply, Hydrologic data, Geology, Data collections.
Identifiers: Berea Sandstone (Ohio), Cussewago Sandstone (Ohio).

A 2-sheet hydrologic atlas presents geologic and hydrologic data governing the occurrence and availability of groundwater in the Berea and Cussewago Sandstones of northeastern Ohio. In some localities the Berea and Cussewago are the only important bedrock sources of fresh water. The map scaled 1:250,000, showing areal extent, thickness, and outcrop area of the Berea Sandstone, indicates that the thickness of the sandstone ranges from a few feet near the edge of the outcrop to more than 235 feet at South Amherst, Lorain County. In most areas the thickness of the Berea Sandstone is an important factor in determining the yield of wells. The coefficient of transmissibility of the Berea Sandstone was estimated to range from about 50 to about 30,000 gpd per ft. Because the Cussewago Sandstone is generally more permeable, its wells generally have higher specific capacities than wells in the Berea Sandstone. The coefficient of permeability of the Cussewago Sandstone in Trumbull County ranges from 100 to 300 gpd per sq ft, and averages about 150 gpd per sq ft, where the saturated thickness ranges from 40 to 130 ft. The coefficient of transmissibility averages 13,000 gpd per ft. The average of dissolved solids in the potable water of the Berea Sandstone is 549 mg/l. Farther south (in Medina, Mahoning, and Stark Counties) total dissolved solids may exceed 76,000 mg/l where the Berea Sandstone contains brine. (Knapp-USGS)
W70-06784

MAXIMUM UTILIZATION OF SCARCE DATA IN HYDROLOGIC DESIGN,
Corps of Engineers, Sacramento, Calif. Hydrologic Engineering Center.
Leo R. Beard, and A. J. Fredrich.
Paper presented at 2nd CENTO Seminar in Hydrology, Teheran, March 1969 (Proceedings in press). 14 p, 4 ref.

Evaluation, Processing and Publication—Group 7C

Descriptors: *Computer programs, *Synthetic hydrology, *Streamflow forecasting, Stream gages, Data processing, Hydrologic data, Hydrology, Digital computers, Statistical methods, Statistics, Data collections, Estimating, Mathematical models.

Identifiers: Stream gage networks.

Methods used for extending available hydrologic information in time and space, most of which involved the use of electronic computers, are described. The incremental value of a single streamflow record at the site of a major reservoir far exceeds the cost of the record, even after more than 100 years of record and even for relatively stable streams. The maximum use of hydrologic information in short records for design purposes can be made by an elaborate analysis of the statistical characteristics of recorded streamflows and use of such statistics to generate long sequences. These sequences can be generated at the gaged locations or, through regionalized studies, at ungaged locations. A comprehensive computer program is available in The Hydrologic Engineering Center, U.S. Army Corps of Engineers, Sacramento, California for analyzing monthly streamflow characteristics, estimating missing values of monthly streamflows at short-record stations based on the longer-record stations in the vicinity, and generating any number of streamflow sequences of any length for use in design. (Knapp-USGS) W70-06788

GROUNDWATER FAVORABILITY AREAS AND SURFICIAL GEOLOGY OF THE LOWER KENNEBEC RIVER BASIN, MAINE,
Geological Survey, Washington, D.C.

Glenn C. Prescott, Jr.

For sale by U S Geological Survey, Wash, D C 20402 - Price \$0.75. Geological Survey Hydrologic Investigations Atlas HA-337, 1 sheet, 1969. Text, 11 fig, 1 tab, 2 map, 4 ref.

Descriptors: *Water resources, *Groundwater, *Maine, Water wells, Aquifers, Water yield, Water quality, Transmissivity, Hydrogeology, Geology, Hydrologic data, Data collections.

Identifiers: Kennebec River basin (Maine).

This report is one of a series describing the geologic and hydrologic conditions governing the occurrence of groundwater in Maine. These reports are intended to provide information to those wishing to develop water supplies, particularly supplies large enough for public or industrial use, from ground-water sources. The magnitudes of yields that might be expected from properly located and constructed wells of 6 inches or more in diameter are indicated by the map showing groundwater favorability areas and surficial geology. A map, scaled 1:62,500, gives a generalized interpretation of observed geologic and hydrologic data. It provides a logical basis for directing detailed exploration for groundwater. Precipitation for the area averages about 43 inches per year. Of this, about 24 inches runs off in streams, and most of the remainder is evaporated or transpired. Of the water that runs off, perhaps as much as 40% is derived from precipitation that has percolated to the water table and thence moved laterally to the streams. This amounts to an average groundwater discharge of about 0.4 mgd per square mile of drainage area. Bedrock wells range from 26 to 700 ft in depth. The average depth was 135 ft and the median depth was 115 ft. The yields of bedrock wells range from 0 to 67 gpm. The average yield is 11 gpm and the median yield is 7 gpm. The groundwater in the area is suitable for most purposes. It is generally low in dissolved solids and free from most constituents that would limit its usefulness. In local areas or in individual wells the water may contain undesirable concentrations of iron, manganese, chloride, or nitrate, or may be exceptionally hard. (Knapp-USGS)

W70-06790

GROUNDWATER RESOURCES OF CRAVEN COUNTY, NORTH CAROLINA,
Geological Survey, Washington, D.C.

Edwin O. Floyd.

For sale by U S Geological Survey, Wash, D C 20402 - Price \$1.00. Geological Survey Hydrologic Investigations Atlas HA-343, 2 sheets, 1969. Text, 5 fig, 3 tab, 5 graph, 5 ref.

Descriptors: *Water resources, *Groundwater, *North Carolina, Aquifers, Water yield, Water quality, Water supply, Water wells, Hydrogeology, Stratigraphy, Hydrologic data, Data collections.

Identifiers: Craven County (N C).

The water used in Craven County, North Carolina is obtained entirely from aquifers. The availability and quality of water in the county are discussed in a 2-sheet hydrological atlas consisting of maps, cross sections, graphs, tabulated data, and text. The amount of water pumped annually in the county is about 40-45 mgd, mainly from aquifer 2, a sandy limestone of Eocene and Oligocene ages. Groundwater is hard everywhere in the county, and too salty to be useful in most of the deeper aquifers. Some saline water encroachment has occurred in parts of aquifer 2. (Knapp-USGS) W70-06791

INTERBASIN DIVERSION OF WATER: AN ANNOTATED BIBLIOGRAPHY,
Texas Tech Univ., Lubbock. Water Resources Center.

George A. Whetstone.

Texas Tech University, Water Resources Center, WRC 70-2, January 1970. 323 p.

Descriptors: *Inter-basin transfers, *Water transfer, *Diversion, *Bibliographies, *Information retrieval, Documentation, Water supply, Water conveyance, Water resources development.

This bibliography was compiled for Water, Inc., an organization interested in the study and advocacy of water importation into the High Plains of New Mexico, Oklahoma, and Texas. It contains 1020 annotated entries on the subject of water transfer between basins. The references, arranged chronologically by year and alphabetically by author within each year, cover the period 1874-1969. There are two indices, one by author and the other by geographical area. The compiler makes no claim that the work is definitive; in fact, a second volume is in preparation. (Carr-Arizona) W70-06816

DATA PROCESSING IN PHILADELPHIA,
Philadelphia Water Dept., Pa.

For primary bibliographic entry see Field 05D.
W70-06890

MANAGEMENT OF POLLUTION DATA USING MODERN TECHNIQUES,
Minneapolis-St. Paul Sanitary District, Minneapolis, Minn.

For primary bibliographic entry see Field 05D.
W70-06922

A SEMANTIC WATER EXCURSION ON SCIENCE, RESEARCH AND TEACHING,
Illinois Univ., Urbana.

For primary bibliographic entry see Field 10.
W70-06938

ENVIRONMENTAL GEOLOGY AS AN AID TO URBAN AND INDUSTRIAL GROWTH IN NORTHWEST ALABAMA,
Alabama State Geological Survey, Tuscaloosa.

For primary bibliographic entry see Field 06B.
W70-06952

COMPUTER CONTROL OF COMBINED SEWERS,
Minneapolis-St. Paul Sanitary District, Minneapolis, Minn.

For primary bibliographic entry see Field 05G.
W70-06954

MAXIMUM FLOODS IN IOWA,
Geological Survey, Iowa City, Iowa. Water Resources Div.
For primary bibliographic entry see Field 02E.
W70-06986

APPLICATION OF A STATISTICAL ZONATION METHOD TO RESERVOIR EVALUATION AND DIGITIZED-LOG ANALYSIS,
Michigan Univ., Ann Arbor. Dept. of Geology and Mineralogy.

Dan Gill.
American Association of Petroleum Geologists Bulletin, Vol 54, No 5, p 719-729, May 1970. 11 p, 8 fig, 18 ref.

Descriptors: *Data processing, *Borehole geophysics, *Subsurface mapping, *Statistical methods, Computer programs, Hydrologic data, Groundwater, Digital computers, Logging (Recording), Subsurface investigations.

Identifiers: Digital data systems, Geophysical logs.

Geologic data are recorded as one-dimensional functions in which each observation is associated with its position on a continuous and ordered location-reference axis. Distinct subsets (zones) within ordered data sets can be recognized and identified statistically by an analysis of variance procedures. An optimal subdivision is attained if zones are established such that the within-zone variance is minimized and the between-zone variance is maximized. The search for the most suitable boundaries is an iterative procedure in which all possible arrangements into two contiguous zones are considered at each stage. The suitability of each proposed boundary is evaluated by computing a zonation index. Examples representative of situations in subsurface geologic studies are presented to illustrate the method. It has wide application in the automation of digitized-log evaluation. It proved useful as a data-reduction tool in the integration of multiwell information into a three-dimensional picture. The method is general and lends itself to many additional applications in geology and other disciplines. (Knapp-USGS) W70-06991

FLOODS IN SYMERTON QUADRANGLE, NORTHEASTERN ILLINOIS,
Geological Survey, Washington, D.C.
Howard E. Allen, Allen W. Noehre, and Leland D. Hauth.

For sale by U. S. Geological Survey, Wash, D C 20402 - Price 75 cents. Geological Survey Hydrologic Investigations Atlas HA-305, 1 sheet, 1970. Text, 11 fig, 2 tab, 1 map, 4 ref.

Descriptors: *Floods, *Illinois, Maps, Stage-discharge relations, Frequency analysis, Streamflow, Flood plains, Flood control, Stream gages, Profiles.

Identifiers: Symerton (Ill.).

This report presents hydrologic data that can be used to evaluate the extent, depth, and frequency of flooding that affect the economic development of flood plains in the Symerton quadrangle, northeastern Illinois. It will aid individuals, government agencies, and others responsible for solving existing flood problems and for formulating effective floodplain regulations that will minimize the creation of new flood problems. The report will also be useful for preparing building and zoning regulations, locating waste disposal facilities, developing recreational areas, and managing surface water in relation to groundwater resources. The areas inundated by floods along streams in the Symerton 7 1/2-minute quadrangle are delineated on a topographic map. The relation between discharge and frequency is shown by graphs. The general relation between recurrence interval and flood height at the gaging station on Hickory Creek at Joliet is tabulated. Profiles of the water surface, based primarily on elevations of marks left by floods of July 1957 and December 1965 are shown. (Knapp-USGS)
W70-07017

Field 07—RESOURCES DATA

Group 7C—Evaluation, Processing and Publication

MAPPING FOR CHANGING ENVIRONMENT,
Geological Survey, Arlington, Va. Topographic
Div.

Morris M. Thompson.

ASCE Proceedings, Journal of the Surveying and
Mapping Division, Vol 95, No SU 1, Paper 6818, p
35-48, October 1969. 14 p, 15 fig, 14 ref.

Descriptors: *Maps, *Mapping, *Topography,
*Automation, Data processing, Computers, Photo-
grammetry, Aerial photography, Remote sensing,
Urbanization, Surveying instruments, Instrumenta-
tion, Terrain analysis, Computers, Natural
resources.
Identifiers: Topographic maps.

Topographic maps provide a vital inventory of man's physical environment. To meet the demand for maps, several approaches can be considered: increased expenditures for mapping, concentration on new mapping, concentration on map revision, or development of better techniques. The only feasible approach today is improvement of techniques. Several avenues for advancing map technology are cited, such as the use of airborne electronic systems for field surveys, the application of new photogrammetric systems for control extension and map compilation, the automation of various cartographic operations and the establishment of computer shortcuts. The orthophotomap is a new kind of map presentation that gives a better inventory of certain environmental situations. To solve the mapping problem in rapidly changing areas, a new 'interim-revision' system provides a means of updating maps at greatly reduced cost. (Knapp-USGS)
W70-07019

**WATER RESOURCES OF THE PINE RIVER
BASIN, SOUTHEASTERN MICHIGAN,**
Geological Survey, Washington, D.C.

R. L. Knutilla.

For sale by U. S. Geological Survey, Wash, D C,
20402 - Price \$0.75 cents. Geological Survey,
Hydrologic Investigations Atlas HA-327, 1 sheet,
1969. Text, 3 fig, 7 map, 2 tab.

Descriptors: *Water resources, *Surface waters,
*Groundwater, *Michigan, Water wells, Stream-
flow, Water yield, Water quality, Aquifers, Water
supply, Base flow.
Identifiers: Pine River basin (Mich.).

The water resources of the Pine River basin, southeastern Michigan are described in a 1-sheet hydrological atlas consisting of 2 maps scaled 1:250,000, and 6 maps scaled about 4 miles to 1 inch. Tables, stream gradient profiles, and water quality graphs are also included. The land surface of the Pine River basin, an area of 194 sq mi, is a relatively flat or gently undulating northwest to southeast trending glacial lake plain. Drainage is not well developed in the basin. Many stream courses are poorly defined, having cut only from 3 to 10 ft below the adjacent plain. For this reason, ditches and drains are necessary to effectively drain parts of the basin. There are a few small scattered ponds, but no lakes within the basin. Water can be obtained almost anywhere in the basin from wells completed in glacial deposits. Surface water in the basin is of a chemical quality generally suitable for most uses. Water from shallow wells, as indicated from analyses in adjacent basins and reflected in the quality of stream waters, is of the calcium magnesium bicarbonate type, but water from wells at depths greater than about 75 ft are of the sodium bicarbonate or sodium chloride type. (Knapp-USGS)
W70-07028

08. ENGINEERING WORKS

8A. Structures

**BANK STABILIZATION IN SUSQUEHANNA
RIVER BASIN,**
Corps of Engineers, Baltimore, Md. Basin Planning
Branch.

For primary bibliographic entry see Field 04D.
W70-06733

**EROSION AND RIPRAP REQUIREMENTS AT
CULVERT AND STORM-DRAIN OUTLETS,**
Army Engineer Waterways Experiment Station,
Vicksburg, Miss.

J. P. Bohan.
Corps Engineers Waterways Experiment Station
Research Report H-70-2, January 1970. 18 p, 8 fig,
20 plate, 4 photo, 8 tab, 11 ref.

Descriptors: *Scour, *Culverts, *Outlet works,
*Riprap, Hydraulics, Erosion, Bank protection, En-
gineering structures, Erosion control, Model stu-
dies, Hydraulic models.
Identifiers: Riprap design.

Experiments were conducted to determine the characteristics of scour below a culvert outlet discharging onto a horizontal blanket of cohesionless soil and to develop guidance for designing riprap protection downstream of culvert and storm-drain outlets. Scour holes, produced by the discharge of various flows of several durations through culverts of various shapes and sizes, were observed and contoured. These data were obtained for several tailwater conditions and were used to develop generalized expressions describing the maximum length, width, depth, and volume of scour as functions of the flow duration and the Froude number of flow at the culvert outlet. Dimensionless scour profiles and cross sections, for low and high tailwater conditions, were also developed. Riprap blankets of various configurations and stone sizes were tested with several culvert sizes and shapes and various tailwater conditions to determine when displacement or failure occurred. The results were used to develop generalized relations to describe the stone size and appropriate blanket configuration required to prevent blanket failure and soil erosion, respectively, at a culvert or storm-drain outfall. (Knapp-USGS)
W70-06753

**HYDROGEN SULFIDE DAMAGE TO
CONCRETE PIPE,**
Seattle Metropolitan Municipality, Wash.

For primary bibliographic entry see Field 05D.
W70-06893

**CHICAGO'S SOUTH WATER FILTRATION
PLANT.**

For primary bibliographic entry see Field 05D.
W70-06919

**CHICAGO WATER SYSTEM, A DESCRIPTION
OF THE SYSTEM AND ITS SANITARY PRO-
TECTION.**

For primary bibliographic entry see Field 05D.
W70-06923

**POTENTIAL IMPACT OF TUNNELS ON
WATER POLLUTION AND FLOOD CONTROL
IN THE CHICAGO AREA,**

Metropolitan Sanitary District of Greater Chicago,
Ill.
For primary bibliographic entry see Field 05G.
W70-06926

**OPTIMUM DESIGN OF COMPLEX WATER
RESOURCE PROJECTS,**
Rand Water Board, Johannesburg (South Africa).
For primary bibliographic entry see Field 06A.

W70-06980

8B. Hydraulics

**MECHANICS OF OPEN-CHANNEL FLOW
SYSTEMS,**
California Univ., Davis. Dept. of Water Science
and Engineering.

Theodor Strelkoff, and Jaime Amorochio.
Available from the Clearinghouse as PB-191 815,
\$3.00 in paper copy, \$0.65 in microfiche. California
University Water Resources Center Research
Project Technical Completion Report, November
1969. 8 p, 17 ref. OWRR Project No B-037-Calif.
(2).

Descriptors: *Open channel flow, *Unsteady flow,
*Mathematical models, Hydraulic models, Model
studies, Non-uniform flow, Channel morphology,
Stage-discharge relations, Canals, Hydraulics,
Hydraulic structures.
Identifiers: Open channel flow mechanics.

Accurate and efficient computational procedures were sought for predicting steady and unsteady flows in open-channel systems. A major element of such systems is a long reach of channel containing a flow that may be variable along its length. Such flows can also be variable with time. Prediction of the resulting time-dependent surface profiles was achieved by the use of a number of finite-difference schemes based upon explicit, implicit, and characteristics approaches. The problem of steep fronted waves—bores—arising as the result of sudden, large changes in channel discharge, was studied and a computational technique developed. Experiments corroborate computed results. Flow profiles and discharges coefficients for a series of hydraulic structures—overfalls, gates, and sills were obtained by analytical means; comparison with experiment shows good agreement. A mathematical model of a complete open channel flow system was developed. A comparison of model results with empirical data taken on a portion of the Delta-Mendota Canal showed good agreement. (Knapp-USGS)
W70-06760

**REPORT ON REQUIRED FACILITIES FOR
REPLENISHING AND PROTECTING GROUND-
WATER RESERVES IN THE CENTRAL AND
WEST COAST GROUNDWATER BASINS, PART
III: DOMINGUEZ GAP BARRIER PROJECT,**
Los Angeles County Flood Control District, Calif.
For primary bibliographic entry see Field 04B.
W70-06917

**REAL TIME ROUTING OF FLOOD HYDRO-
GRAPHS IN STORM SEWERS,**
Minnesota Univ., Minneapolis. St. Anthony Falls
Hydraulic Lab.
For primary bibliographic entry see Field 07B.
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Purdue Univ., Lafayette, Ind.
For primary bibliographic entry see Field 04A.
W70-07003

**HODOGRAPH SOLUTION OF THE DRAINAGE
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Agricultural Research Council, Cambridge (Eng-
land). Unit of Soil Physics.
For primary bibliographic entry see Field 04A.
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**STATISTICAL ROUGHNESS PARAMETER AS
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SISTANCE,**
Pittsburgh Univ., Pa.
For primary bibliographic entry see Field 02E.
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SOME FINITE DIFFERENCE SOLUTIONS FOR THE DISPERSION OF THERMAL SOURCES IN STEADY PRISMATIC FLOW,
Rutgers - The State Univ., New Brunswick, N.J.
For primary bibliographic entry see Field 05B.
W70-07014

SEEPAGE FROM TRAPEZOIDAL CHANNELS,
Uttar Pradesh Irrigation Research Inst., Roorkee
(India).
For primary bibliographic entry see Field 04A.
W70-07016

HYDRAULIC DESIGN OF SELF-CLEANING SEWAGE TUNNELS,
Norges Tekniske Høgskole, Trondheim.
For primary bibliographic entry see Field 05D.
W70-07046

VARIATION OF ALPHA AND BETA VALUES IN A LINED OPEN CHANNEL,
Colorado State Univ., Fort Collins. Coll. of Engineering, and Geological Survey, Fort Collins.
For primary bibliographic entry see Field 02E.
W70-07092

8C. Hydraulic Machinery

ROCKY REACH DAM TURBINE RATINGS BY THE CURRENTMETER METHOD,
Beck (R. W.) Associates.

S. M. Alexander.
Public Utility District No 1, Chelan County, Wenatchee, Wash., Columbia River Turbine Discharge Rating Program Report, December 1969. 63 p, 25 fig, 16 plate, 8 tab, 4 append.

Descriptors: *Current meters, *Discharge (Water), *Hydroelectric plants, *Columbia River, *Washington, Data collections, Hydrologic data, Open channel flow, Closed conduit flow, Stage-discharge relations, Instrumentation, Stream gages, Velocity, Flow measurement, Rotating meters.
Identifiers: Rocky Reach (Wash.).

A total of 49 discharge measurements were made in the turbine intakes of the units at the Rocky Reach Project, Columbia River, Washington by the multiple currentmeter method. Simultaneous measurements of spiral case piezometer pressures and of related parameters permitted the evaluation of a calibration equation for the piezometer taps at each unit. Measurements of gross head and generator output were made during the currentmeter measurements to permit determination of a unit performance curve at the test head condition. Simultaneous measurements were made of gross head and power output to provide unit performance curves at the test head. An average unit performance curve was developed for the six units defining the relationship between discharge, power output and gross head. Approximately 75% of all test points fell within 2% of the mean unit performance curves. (Knapp-USGS)
W70-06776

THEORIES AND MEASUREMENTS IN CHARACTERISTIC PROBLEMS OF HYDROSTATIC VANE PUMPS (IN GERMAN).
Technische Hogeschool, Eindhoven (Netherlands).

Peter Wuesthof.
Available from the Clearinghouse as N70-14403, \$3.00 in paper copy, \$0.65 in microfiche. Ph. D. Thesis, Nov 18, 69. 129 p 73 ref.

Descriptors: *Fluid mechanics, *Hydraulic equipment, *Hydrostatic pressure, *Pumps, Impellers, Mechanical properties.
Identifiers: *Vanes.

Although hydraulic vane pumps do not reach comparable pressures and efficiency degrees as piston pumps, their simple construction allows for direct

transfer of mechanical energy into hydraulic energy. The development of vane pump families from otherwise unchanged basic units through change of displacement capacity is only possible to a limited degree. Axle inclination difference cannot be extended unlimited in relationship to blade dimension. Only one third of the blade surface is utilized for pressure production during displacement motion whereas two thirds of the vane remain in the motor slit. Vane pumps that exceed the correlation of lift height and blade dimension by a factor of 8 are not practical.
W70-06845

ALTERNATIVES FOR SLUDGE DISPOSAL, METROPOLITAN SEWERAGE SYSTEM,
San Diego Dept. of Utilities, Calif.
For primary bibliographic entry see Field 05E.
W70-06916

MAIN STATION CONTROL,
Louisville Water Co., Ky.
Frank C. Campbell.
November 17, 1969. 10 p, 1 fig, 1 tab.

Descriptors: *Control systems, *Instrumentation, *Remote control, *Automation, *Automatic control, *Waste water treatment, *Pumping, Pumps, Monitoring.
Identifiers: *Louisville Water Plant.

This report outlines the installation and operations of a proposed Main Station Control for the Louisville Water Treatment Plant to provide a central location where all primary pumping units can be controlled and the auxiliary systems monitored. The control will consist of a central panel flanked by control modules for each of six existing primary pumping units. The purpose of the control panel is to consolidate all monitoring and control devices that indicate station operating conditions which are common to each primary electrical pumping unit. There will be a graphic control panel to indicate which primary units are in operation and to show a schematic outline of the station headers and control valves. There will be an alarm section to indicate loss of voltage, open circuit breakers, incorrect header discharge pressure, low clear-well level, flooding, and plant security. The primary electric pumping unit control module will contain an electrical power section, ready systems monitoring, pump operation conditions section and an alarm section. Main station control and instrumentation should increase the dependability of operation. Design flexibility will be built into the system to allow for full automation in the future. The estimated cost of the installation is not available at this time. (Poertner-Chicago)
W70-06924

CHICAGO'S CENTRAL WATER FILTRATION PLANT.

Department of Water and Sewers, Chicago, Ill.; and Department of Public Works, Chicago, Ill.

Report, 1966. 24 p, 26 fig.

Descriptors: *Water treatment, *Water purification, *Filtration, *Filters, *Water supply, *Water works, *Treatment facilities, *Construction, Operations, Monitoring, Data collections, Instrumentation.
Identifiers: *Chicago Water Department.

The operation of Chicago's Central Water Filtration Plant is described. The plant is the world's leader in output. It produces filtered water at a rate of 960 million gallons a day. Located on a 61 acre peninsula on Lake Michigan the plant normally receives raw water through tunnels from intake cribs located in Lake Michigan. A shore intake is also available. The filtration process starts at the north end of the plant where the water is brought in. After passing through 8 screens, the water is pumped to an elevation of 21 feet and flows by gravity through the rest of the processes. Chemicals

are added, using the most advanced feeding systems, as the water flows to the mixing basins, then on to the settling basins where 85 to 90 per cent of the impurities are removed by sedimentation, enhanced by alum-floc coagulation. The water is then passed on to the filtration building where the final polishing operation is completed before flowing into clearwells and thence to the filtered water reservoir awaiting distribution. The processes, from start to finish, are monitored, centrally displayed and recorded, supervised, and manually controlled using a centralized complex of special instruments and a computer-data-logger. A closed-system television system is used for making visual checks of strategic points. Information gathered is used to increase efficiency of plant operations. (Poertner-Chicago)
W70-06927

JURISDICTION OF THE FEDERAL POWER COMMISSION OVER NON-POWER WATER USES,

For primary bibliographic entry see Field 06E.

W70-07062

8D. Soil Mechanics

COMPRESSIBILITY AND CRUSHING OF GRANULAR SOIL IN ANISOTROPIC TRIAXIAL COMPRESSION,
California Univ., Los Angeles. Dept. of Engineering.

Kenneth L. Lee, and Iraj Farhoondan.
Canadian Geotechnical Journal, Vol 4, No 1, p 68-99, February 1967. 32 p, 11 fig, 1 tab, 21 ref., discussions. NSF Grant No GK 921.

Descriptors: *Soil mechanics, *Soil strength, Laboratory tests, Compressive strength, Porous media, Filtration, Permeability, Dam construction, Earth materials, Soil compaction, Soil engineering.
Identifiers: Soil crushing strength.

Isotropic and anisotropic triaxial compression tests were performed on a number of sands and gravels. A review was made of the results reported by others. Granular soil is quite compressible under an applied stress. Compression is usually accompanied by a certain amount of particle breakage, and the two phenomena seem to be somewhat related to each other. Coarse soils compress more and show more particle crushing than fine soils. Soils with angular particles compress more and show more particle crushing than soils with rounded particles. Uniform soils compress and crush more than graded soils with the same maximum grain size. Under any particular load, compression and particle crushing continue to increase at an ever-decreasing rate for an indefinite period of time. Although a considerable amount of particle crushing will occur under the stress conditions likely to exist near the base of a large earth dam, data suggest that this crushing will probably not be detrimental to the function of gravel drains or soil filters. (Knapp-USGS)
W70-06800

COASTAL ENGINEERING ASPECTS OF AN AIRPORT IN LAKE MICHIGAN,
Department of Public Works, Chicago, Ill.

Milton Pikarsky.

A paper presented at the Annual and Environmental Meeting of the American Society of Civil Engineers, Chicago, October 13-17, 1969; Meeting Preprint 1065. 20 p.

Descriptors: *Airports, *Dikes, *Lake beds, *Lake Michigan, *Aircraft, *Water values, *Water resources, *Coastal engineering, Hydraulic engineering, Soil engineering, Construction, Construction costs.
Identifiers: *Chicago, *Polder.

The cost, feasibility, and construction aspects of building an Airport in Lake Michigan are

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discussed. One proposal is the construction of a circular polder (an acre of lake bottom uncovered by pumping out the water within the confines of a circular dike) about 5 miles in diameter, 11,000 acres in area and centered about 8 miles offshore in Lake Michigan. The circular dike would be about 82,000 ft. long and would require approximately 150,000,000 cubic yards of fill. It was found through field investigations that there are several sites near the lake where the fill could be mined. A lake quarry would satisfy the needs and would also help to reduce costs. The only conventional alternatives to a polder for a lake site are an island or a peninsula. This would require much more fill (1,064 million cubic yards) in addition to the required material for the dike proper. Harza Engineering Company, after completing engineering studies, evaluation of lake bottom borings, and a seismic survey has concluded that the lake airport site is entirely feasible. They estimate that the polder in Lake Michigan would cost approximately \$500,000,000. Construction time is estimated to be 5 or 6 years. Chicago is awaiting information from the FAA on air space simulation studies before deciding upon the site for its next airport. (Poertner-Chicago)
W70-06921

8E. Rock Mechanics and Geology

COMPRESSIBILITY AND CRUSHING OF GRANULAR SOIL IN ANISOTROPIC TRIAXIAL COMPRESSION,

California Univ., Los Angeles. Dept. of Engineering.
For primary bibliographic entry see Field 08D.
W70-06800

8H. Rapid Excavation

INGRAM V GREAT LAKES PIPE LINE CO (DESTRUCTION OF SPRING BY BLASTING)

For primary bibliographic entry see Field 06E.
W70-07118

10. SCIENTIFIC AND TECHNICAL INFORMATION

INTERBASIN DIVERSION OF WATER: AN ANNOTATED BIBLIOGRAPHY,

Texas Tech Univ., Lubbock. Water Resources Center.

For primary bibliographic entry see Field 07C.
W70-06816

A SEMANTIC WATER EXCURSION ON SCIENCE, RESEARCH AND TEACHING,

Illinois Univ., Urbana.

Icko Iben.

Proceedings of the Third American Water Resources Conference (American Water Resources Association, Urbana, Illinois, 1967, p 603-607, 4 ref.

Descriptors: *Communication, *Water resources, *Information retrieval.

The subject of communication in water resources is considered with reference to the term deontology. This term used by Jeremy Benthen means 'Knowledge of what is right or proper,' 'As an art, it is doing what is fit to be done, as a science, it is knowing what is fit to be done on every occasion.' The author stresses that water men will do what is fit to be done if they know what is fit to be done. Accordingly, the American Water Resources Association has as two of its three stated objectives: the establishment of a common meeting ground for members of the profession; and the collection, organization and dissemination of ideas and information in the field of water resources science and technology. The need for collecting records of action that have been reduced in quantity to archives is discussed. This need is not only directed toward documents of practical value but also toward those with historical value. The American Water Resources Association and the Science Information Service of the Smithsonian Institution are mentioned in this regard along with the American Water Resources Library established at Urbana, Illinois, in 1965. The latter is discussed with some attention paid to procedures and lines of communication with publications such as Hydata, AWRA Bulletin and AWRA News-Letter. Means of collecting literature earlier than 1964 are discussed. Finally, with growing collections, the need for an information center will become more acute. Plans for dealing with this, including the publication of Hydata, are discussed. (Preckwinkle-Chicago)
W70-06938

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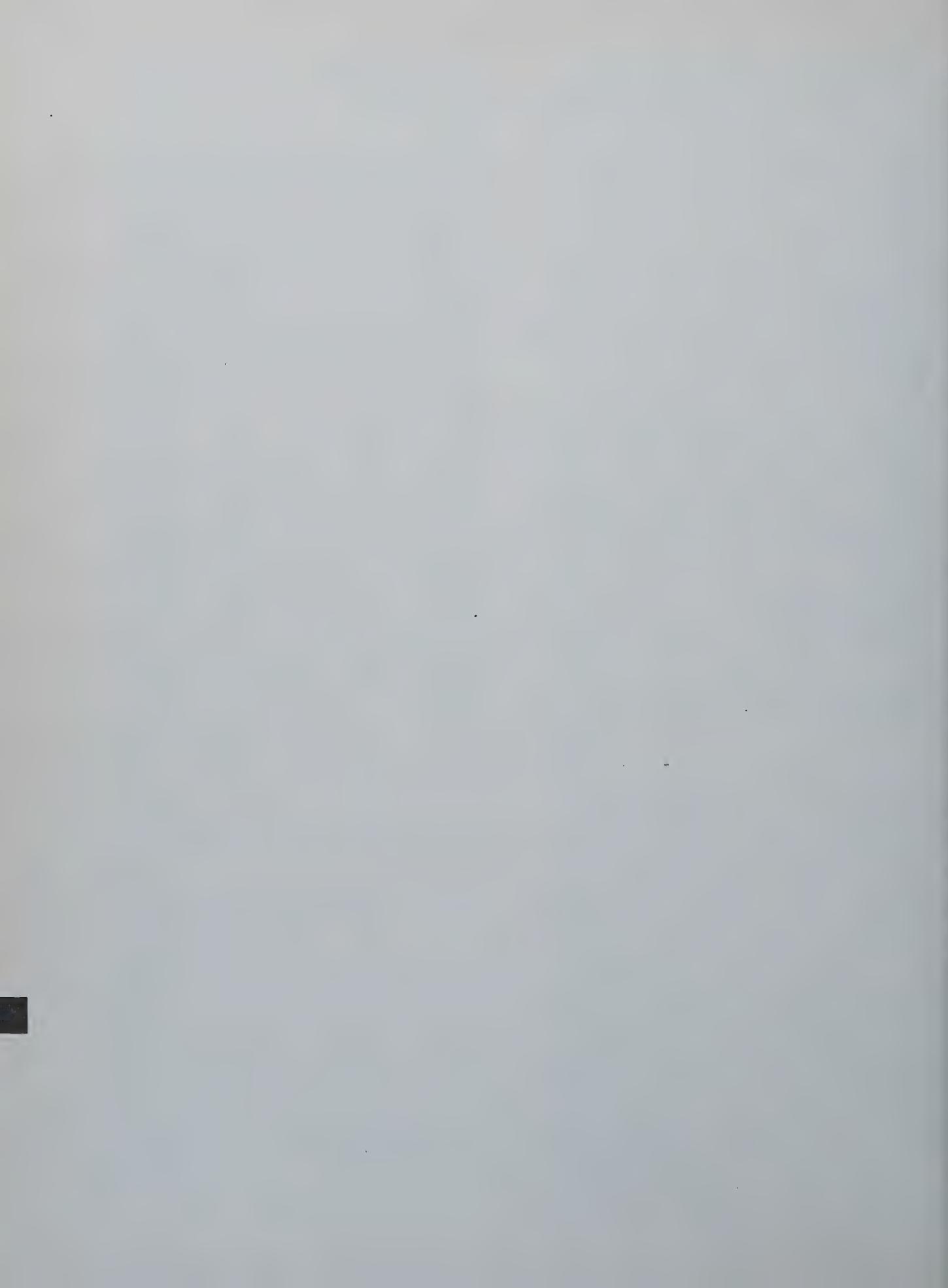
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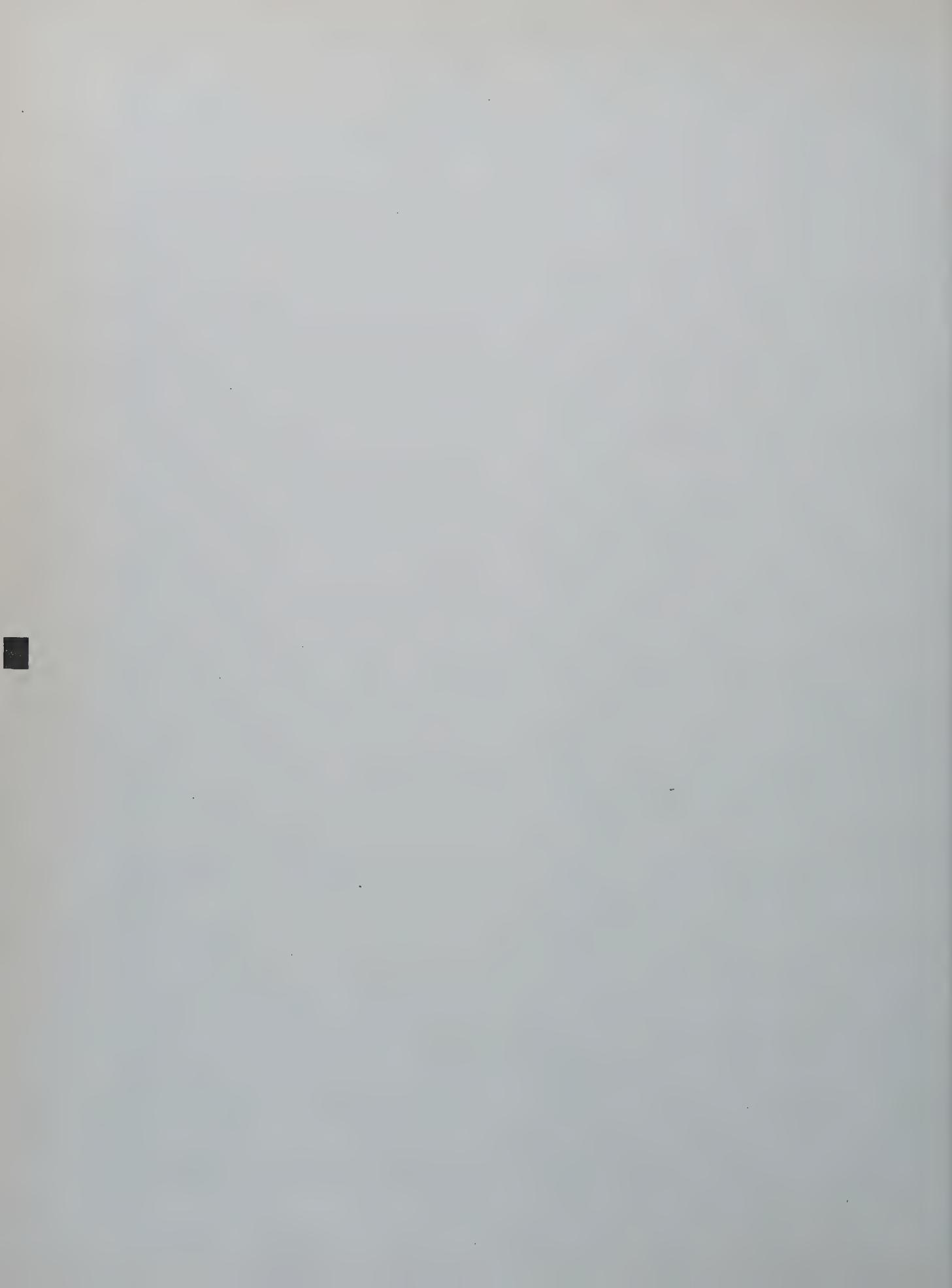
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